THE EFFECTS OF MOTOR IMAGERY ON STRENGTH PERFORMANCE

by

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DEDICATION PAGE

This thesis is dedicated to my grandpa Jim, Grandpa Ron and grandma Piggy. Thank you so much for all the support, warmth, and love throughout my entire life. I could not have asked for more, Love you forever!!!

Grandma Ola, I will never be able to repay the support, talks and guidance you have provided throughout my life. I always try to carry myself to standards that would make you proud and live by the example you have set for everyone. I love you very much, and your life lessons will never be forgotten.

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ABSTRACT

Preliminary research has shown the combination of strength training and motor imagery can increase isometric force production. This study explored the impact of motor imagery on dynamic strength using a 3RM bench press and back squat. Participants were randomized into either the treatment or placebo condition. Each group engaged in an 11 week training program and used motor imagery (n=8), or listened to motivational music (n=7). Results for both the upper and lower body strength showed a significant overall main effect for time from baseline to post-test measure (upper body: motor imagery: M= 43.5 kg, SD= 18.65 kg to M= 60.7 kg, SD= 24.0 kg; placebo: M= 45.0 kg, SD= 15.54 kg to M=55.0 kg, SD=17.9 kg; p=.000) (lower body: motor imagery: M= 82.9 kg, SD= 29.72 kg to M=110.0 kg, SD= 23.4 kg; placebo: M= 84.6 kg, SD= 20.29 kg to M=119.3 kg, SD= 24.6 kg; p=.000). The upper body strength displayed a significant interaction effect (p=.001) between program type and time, while lower body strength had an insignificant interaction effect (p=.162, η_p^2=.162). Finally, there was no significance between the overall main effect and group allocation for upper body (p=.870, η_p^2=.002) and lower body (p=.818, η_p^2=.004) strength. While preliminary, these results suggest that motor imagery may have an impact on the development of strength over an 11 week training program. However, further understanding of imagery use and how it impacts strength is needed.

LIST OF ABBREVIATIONS USED

F.I.T.T	Frequency, Intensity, Type, Time
1RM	One Rep Maximum
EMG	Electromyography
CSCA	Canadian Sport Center Atlantic
MIQ	Movement Imagery Questionnaire
MIQ-R	Revised Movement Imagery Questionnaire
PETTLEP	Physical nature, Environment, Task, Timing, Learning, Emotion, and Perspective
WLIQ	Weight Lifting Imagery Questionnaire
PI	Principal Investigator
PAR-Q	Physical Activity Readiness Questionnaire
CSEP	Canadian Society of Exercise Physiology
LTAD	Long Term Athlete Development
RA	Research Assistant
CSCS	Certified Strength and Conditioning Specialist
BIA	Bioelectrical Impedance Analysis
3RM	Three Repetition Maximum
ANOVA	Analysis of Variance

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CHAPTER 1 INTRODUCTION

Athletes are always trying to find ways to maximize performance in sport. Currently, there are a variety of different methods used to enhance an athlete's performance. Increasing strength, imagery, and technical practice are some of the more commonly used techniques (Martens, 2004). More recently, research has begun to investigate the effects of combining both strength training and imagery into improving an athlete's strength performance (Folland & Williams, 2007; Lebon, Collet, & Guillot, 2010; Silbernagel, Short, & Ross-Stewart, 2007). When an athlete utilizes imagery that focuses on maximal muscular contraction during a movement, it is termed motor imagery (Lebon et al., 2010; Reiser, Busch, & Munzert, 2011; Reiser, 2005). Research has shown that motor imagery can increase the isometric force production of a muscle (Ranganathan, Siemionow, Liu, Sahgal, & Yue, 2004; Reiser et al., 2011; Reiser, 2005; Smith, Collins, & Holmes, 2003; Yue & Cole 1992; Zijdewind, Toering, Bessem, Van Der Laan, & Diercks, 2003). This increase in force production has been presented in both small and large muscles of the upper and lower body (Reiser et al., 2011). However, the current body of literature has failed to present the effects of motor imagery on dynamic strength performance. Additionally, there were no research studies found which combined motor imagery and a structured strength training plan.

As a result the transferability of motor imagery to athletic performance is not fully understood. Therefore, a study which combines a motor imagery program with a structured strength training plan, while assessing dynamic strength performance is needed to explore whether motor imagery can to improve athletic performance in strength training.

CHAPTER 2 LITERATURE REVIEW

2.1 STRENGTH TRAINING IN ATHLETES

Strength training is a method of exercise used to enhance athletic performance, augment musculo-skeletal health, and alter body aesthetics (Baechle & Earle, 2008; Folland & Williams, 2007; Saladin, 2007). By establishing a base for power and agility, an athlete's strength serves as the foundation for all movements in sport. The benefits received from a given exercise program are commonly based on the F.I.T.T principle, defined as frequency, intensity, type and time principle (Baechle & Earle, 2008; Peterson, Rhea, & Alvar, 2005). The *Frequency* of the exercise, accounts for how often one trains. The *Intensity*, relates to how hard the athlete is working and is generally quantified by using a percentage of a person's one repetition maximum (1RM) (Baechle & Earle, 2008; Bompa & Haff, 2009; Knuttgen & Kraemer, 1987; Kramer, 1983). The *Type* of exercise encompasses the specific movements (e.g., back squat) one would be executing within a program as well as the energy system (e.g., anaerobic) placed under stress. Finally *Time*, is the duration each workout lasts. Utilizing the F.I.T.T. principle enables an athlete to manipulate the outcomes of an exercise program by varying the training stimulus (Baechle & Earle, 2008).

2.2 STRENGTH TRAINING AND PERIODIZATION

The ability of an athlete and coach to manipulate the structure (e.g., 8 vs. 12 repetitions) of one's strength training in order to achieve the desired performance benefits (e.g., muscular hypertrophy vs. maximum strength) is imperative to athletic performance (Baechle & Earle, 2008). The athlete/coach must recognize the different energy systems (e.g., aerobic or anaerobic system) and muscular movements (e.g., muscular endurance or muscular power) utilized within a given sport to select appropriate exercises and training modalities (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Issurin, 2010; Plisk & Stone, 2003). This is done by creating a structured periodized training plan which can be broken down into distinct training phases (e.g., main adaptation phase or tapering phase) with distinct training goals (e.g., increase maximum strength or maximum power) (Bompa & Haff; Busso, 2003; Issurin, 2010; Plisk & Stone, 2003). A typical periodized training plan for an athlete is broken down into four larger cycles known as macrocycles, which last 1 to 6 months depending on the focus and time of year. The typical structure of an athletic season macrocycles are known as the off-season, pre-season, in-season, and post season (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Issurin, 2010; Plisk & Stone, 2003). Macrocycles can be further broken down to mesocycles (2 to 6 weeks) and microcycles (1 week). The combination of these cycles, are used to organize, plan and maximize performance gains within an athlete's training program.

The off-season macrocycle of an athlete's program focuses on maximizing the energy systems and muscular movements of an athlete's respective sport (Baechle & Earle, 2008; Bompa & Haff, 2009). During this macrocycle, the training load for an athlete will fluctuate between periods of high and low intensity or volume. This allows the athlete to adapt to a given training load, experience increases in the given training variable (e.g., muscular strength) and prevent overtraining or burnout (Baechle & Earle, 2008; Bompa & Haff, 2009). After prolonged periods of high intensity exercise, if the athlete is not allowed to adapt from a given training stress, there is an increased risk of overtraining. Overtraining is defined as excessive frequency, volume or intensity of training resulting in chronic fatigue which cannot be overcome (Baechle & Earle, 2008). The buildup of chronic fatigue can result in psychological and physiological disturbances which negatively affect performance

(Baechle & Earle, 2008; Bompa & Haff, 2009). In order to prevent these negative outcomes and promote muscular adaptation, a decrease in training volume must occur to allow for rest and recovery (Baechle & Earle, 2008; Bompa & Haff, 2009). A period with planned decreases in training volume, is termed as a tapering phase (Baechle & Earle, 2008; Bompa & Haff, 2009; Stone, Stone, & Sands 2007). During the tapering phase there is a decrease in physical strain, allowing the athlete to recover and adapt. This results in a rebound effect and subsequent increase to baseline performance (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Issurin, 2010; Plisk & Stone, 2003). The tapering phase lasts one to two weeks, depending on the level of intensity of the previous training phase. The tapering phase is also used prior to a major competition as a tool to promote peak athletic performance (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Issurin, 2010; Plisk & Stone, 2003).

A tapering phase does increase strength performance through the recovery from physical stress. However, if one were able to provide a stimulus which continued to engage the muscle without physical strain a greater rebound or increase in performance is plausible (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Issurin, 2010; Plisk & Stone, 2003). Motor imagery is the mental representation of an overt action without any associated body movement, which utilizes the kinesthetic perspective of imagery (Ranganathan et al., 2004; Reiser et al., 2011; Smith et al., 2004; Yue & Cole, 1992; Zijdewind et al., 2003). Motor imagery has been found to increase muscle force production (Ranganathan et al., 2004; Reiser et al., 2011; Smith et al., 2004; Yue & Cole, 1992; Zijdewind et al., 2003). This suggests motor imagery may be a useful component of an athlete’s training program with the potential to increase strength performance beyond that of physical strength training alone.

2.3 MUSCULAR ADAPTATIONS IN STRENGTH TRAINING

During a strength training program, an athlete will undergo a variety of physiological, morphological and neurological adaptations (e.g., increase in muscle fiber size, muscle efficiency, and neural activation) (Baechle & Earle, 2008; Folland & Williams, 2007, Gabriel, Kamen, & Frost, 2006; Saladin, 2007). Within the first few weeks of a new program the majority of strength gains are attributed to neurological adaptations (Folland & Williams, 2007; Gabriel et al., 2006; Lebon et al., 2010). These neurological adaptations begin in the motor cortex, with an increased ability in motor unit activation (Baechle & Earle, 2008). This is a result of increased activity in the primary motor cortex during periods of high force production or the learning of a new movement. Neural adaptations also occur in the spinal cord within the descending corticospinal tracts (Baechle & Earle, 2008; Folland & Williams, 2007; Gabriel et al., 2006; Holmes & Collins, 2002). Trained individuals display a greater ability to maximally recruit motor units, and show a greater potential to recruit fast twitch muscle fibers (Adams, Harris, Woodward, & Dudley, 1993; Dettmers, Ridding, Stephan, Lemon, Rothwell, & Frackowiak, 1996; Holmes & Collins, 2002). Additional adaptations occur within the motor unit of the neuromuscular system.

The motor unit consists of an alpha neuron and the muscle fibers it innervates. In order to produce maximal force all available motor units are recruited (Baechle & Earle, 2008; Folland & Williams, 2007; Gabriel et al., 2006; Holmes & Collins, 2002). The amount of force is affected by the firing rate of the affected motor unit. Heavy resistance training results in an increase in motor unit recruitment, rate of firing and synchronization of firing (Baechle & Earle, 2008; Folland & Williams, 2007; Gabriel et al., 2006; Fleck & Kramer, 2003; Sale, 2003). Generally, the recruitment of motor neurons is governed by the size principle. This principle states motor units are recruited based on their force threshold, therefore, smaller motor units are recruited prior to larger ones (Sale, 2003). When individuals are trained using heavy resistance training, the central nervous system can adapt to bypass smaller motor units resulting in a greater and more rapid force production (Baechle & Earle, 2008; Gabriel et al., 2006; Holmes & Collins, 2002; Fleck & Kramer, 2003; Sale, 2003). Numerous studies have examined the use of an electromyography (EMG) to detect neuromuscular activity of a motor unit (Folland & Williams). An EMG detects the magnitude of neural activation. Collectively, a 73% increase in both power and maximum strength have been found in studies lasting five weeks to over one year (Baechle & Earle). Furthermore, 70% of these studies showed an increase in EMG activity within the working muscle from pre to post-test measures.

Finally, the neuromuscular junction is the final site for potential neural adaptation (Baechle & Earle, 2008). The neuromuscular junction is the interface between the nerve and skeletal muscle (Deschenes et al., 2000; Holmes & Collins, 2002). Heavy resistance training produced more dispersed synapse, greater length of nerve terminal branching, and greater dispersion of acetylcholine receptors across the end plate. The combination of these factors promotes greater force production and coordination within the motor unit (Baechle & Earle, 2008).

The increase in motor unit coordination occurs as a result of the body adapting to a new movement and is referred to as a “skilled act” (Folland & Williams, 2007). This movement must be executed with the agonist muscle experiencing maximal activation, supported by the appropriate synergist and stabilizers muscles. Lastly, the antagonist muscle must have minimal activation (Baechle & Earle, 2008; Gabriel et al., 2006; Sale, McDougall, Upton, & McComas, 1983). With the combination of these factors, maximal neurological integration will occur resulting in optimal movement pattern. As highlighted, neurological adaptations are only one part of the many components which contribute to increases in strength performance (Baechle & Earle, 2008). However, recent research suggests that the only way to measure the transferability of strength gains to the athlete's sport performance is through neurological adaptations (e.g., increase in muscle efficiency/ neural activation) (Canadian Sport Center Atlantic (CSCA), 2010; Favlo, Sirevaag, Rohrbaugh, & Earhart, 2010; Reiser et al., 2011). This hypothesis infers that an increase in overall muscle efficiency in the execution of an exercise will transfer to an increase in muscle efficiency within a sport based movement. Therefore, focusing on developing neurological adaptations throughout a strength training program would appear to be paramount.

2.4 IMAGERY

Imagery is a very popular technique for improving an athlete's performance within sport (e.g., foul shooting) (Driskell, Copper, & Moran, 1994; Martin, Moritz, & Hall 1999; Savoy & Beitel, 1996; Silbernagel et al., 2007). This can be achieved through imaging skills and techniques, team strategies, as well as arousal control (Paivio, 1985). Imagery is achieved through the athlete experiencing the stimulation of all five senses without physical movement, and if imagery is executed correctly the athlete should be able to feel, hear, see, smell, and taste the movement and environment (Hall, Rodgers, & Barr, 1990; Holmes & Collins 2002; Silbernagel et al., 2007). Additionally, the image itself can be done in either the internal "first person" or external "third person" described as "seeing", versus a kinesthetic "feeling" perspective. An example of an internal imagery perspective is looking through one's own eyes when shooting a free throw in basketball. In this scenario one would see their hands on the ball, as well as see the net and players around them whereas, external imagery perspective would be looking at the whole body shooting a free throw (Crocker, 2007). This perspective would be like watching one move through the lens of a video camera. The kinesthetic perspective focuses on the sensations one would feel when executing a movement (i.e. muscle contractions) (Wright & Smith, 2009). Skilled imagery users are able to move between these three perspectives, allowing them to fully maximize the benefits of a given imagery program (Holmes & Collins, 2002; Lebon et al., 2010).

Although imagery is an excellent tool for an athlete, it requires experience and skill in order to be executed effectively (Martin et al., 1999; Schuster et al., 2011). Additionally, Hall and Rodgers (1990) found that athletes with a greater ability to image had more effective and frequent use of imagery. Therefore practice of proper technique and instruction must be used to maximize the benefits of imagery

In order to provide structure and increase effectiveness of teaching, or using a variety of imagery techniques, Holmes and Collins (2002) developed the PETTLEP model. This model enables one to increase the functional equivalence of an imaged movement, which is an imperative component to optimal imagery use (Holmes & Collins, 2002; Wright & Smith, 2009). Specifically, this model enables one to optimize the potential benefits of using imagery through the consideration of the: Physical, Environment, Type of Task, Timing, Learning, Emotional aspects, and Perspective of the image being executed (Holmes & Collins, 2002; Wright & Smith, 2009). The Physical represents the athlete's physical responses in a sporting situation. This is an important consideration, because research has shown that a relationship exists between the functional equivalence to the physical task and the potential benefits one may receive from motor imagery (Smith & Collins, 2004; Smith & Holmes, 2004). Holmes and Collins argue that one should hold any implements that would be used in the physical execution of the task, in order to fully replicate the physical task.

The Environment relates to the physical environment in which a task would be performed (e.g., a weight room; Holmes & Collins, 2002). Therefore to access the same motor representation as a physical movement, imagery should be executed either in the same environment as the physical task or a space which closely resembles the task environment. Holmes and Collins, suggest that the use of photographs, environment noise or videos can aid in replicating the physical space. These different environmental cues enable one to enhance the functional equivalence of the task being imaged.

The Task component suggests that the imaged task needs to closely represent the actual task (Holmes & Collins, 2002). Therefore the same thoughts, feelings, actions and actual equipment used by the athlete should be imaged. If one uses a certain brand of equipment, Holmes and Collins suggest one should image themselves using that equipment.

The Timing component of the model suggests that the imaged execution of the skill should be at the same tempo as the physical movement, therefore imagery should not always be done in slow motion (Holmes & Collins, 2002). For example, when imaging a back squat the eccentric and concentric portions of the squat should take the same amount of time as the physical set (e.g., one second for eccentric and one second for concentric).

The Learning portion of the model considers the level of task and imagery expertise of the athlete. Therefore, an expert imager or mover may require a different imagery script than a novice. In addition an experienced athlete may focus on different aspects of the movement compared to a novice (Wright & Smith, 2009). As one’s skill level increases the motor representation and associated response will change. As a result one should consider changing the script in order to achieve optimal gains (Holmes & Collins, 2001). Holmes and Collins (2002), further suggest that regularly reviewing the imagery content is critical to the maintenance of functional equivalence.

The Emotion of an image is imperative to the maintenance of functional equivalence. This aspect of imagery can often be overlooked, or misinterpreted (Wright & Smith, 2009). An athlete should experience all the emotions and arousal associated with a physical movement when imaging (Botterill, 1997). Research has shown that optimal imagery performance occurs when an individual attaches meaning and emotional responses to the sporting situation. However, Holmes and Collins (2002) note that accurate emotions are imperative in maintaining functional equivalence. Furthermore unwanted negative emotions have to be avoided and controlled. They further suggest that athletes must be proficient at interpreting and overcoming any unwanted emotions.

Finally, the Perspective of an image is the last component of the PETTLEP model (Holmes & Collins, 2002). This refers to the way the image is viewed. As discussed above there are different perspectives an imager can utilize (e.g., kinesthetic). Studies have shown improvement in task performance from all imagery perspectives (Reiser et al., 2011; Savoy & Beitel, 1996; Wright & Smith, 2009). Therefore it would appear beneficial for an athlete to be able to move between perspectives. However, certain perspective may more effective at achieving specific outcomes (Wright & Smith, 2009). Therefore one may assume understanding the goals and type of imagery use would be of importance.

2.5 MOTOR IMAGERY

Motor imagery is a type of imagery that is executed without the presence of physical movement (Reiser et al., 2011; Ranganathan et al., 2004; Smith et al., 2004; Yue & Cole, 1992; Zijdewind et al., 2003). Motor imagery focuses on imaging the kinesthetic feel of maximal muscular contraction and not sport technique or arousal control. Proper use of motor imagery requires an appropriate level of skill in order to fully optimize the benefits. In an effort to assess motor imagery, Hall and Martin (1997) created the Movement Imagery Questionnaire (MIQ), and later a shortened version known as the Revised Movement Imagery Questionnaire (MIQ-R). Both tools have been used extensively in motor control, rehabilitation and sport related imagery research as they assess both the visual (e.g., focusing oneself through the perspective of a video camera) and kinesthetic (e.g., focusing on feeling your muscles during the movement) aspects of imagery (Gregg, Hall, & Butler, 2007; Reiser et al. 2011; Reiser, 2005). Gregg et al. (2007) found athletes tend to perform visual images more easily then kinesthetic ones. Gregg et al., further suggest one should consider teaching visual imagery prior to kinesthetic imagery, with the use of guidelines to enable appropriate imagery technique. Therefore, the development of a structured motor imagery program is imperative to achieving the desired performance outcomes.

Motor imagery research done without structured guidelines, found that motor imagery had no effect on isometric force production (Herbert, Dean, & Gandevia, 1998; Tenenbaum, et al., 1995). These finding are not consistent with recent research (Ranganathan et al., 2004; Reiser et al., 2011; Reiser, 2005; Zijdewind et al., 2003), and Ranganathan et al. suggested that the experimental design and motor imagery instructions given were the primary reasons for the absence of strength performance gains observed in the Herbert et al. and Tenenbaum et al. studies. Herbert et al. and Tenenbaum et al. used an imagery design that focused on the use of a visual perspective. However other research suggests the visual perspective fails to provide optimal functional equivalence, which in turn would not effectively provide a stimulus to the muscle (Wright & Smith, 2009). Moreover, motor imagery research which utilizes guidelines aimed at optimal functional equivalence, such as the Holmes and Collins (2002) PETTLEP model, found motor imagery increased force production (Ranganathan et al., 2002; Reiser, 2005; Smith et al., 2003; Wright & Smith; Zijdewind et al., 2003). This reiterates the importance of a properly structured motor imagery program in ensuring functional equivalence to attain desired strength performance improvements.

2.6 IMAGERY AND STRENGTH TRAINING

A study investigating the use of imagery in relation to exercise with recreational males utilized the Weight Lifting Imagery Questionnaire (WLIQ) (Munroe-Chandler, Kim, & Gammage, 2004). The WLIQ assessed the type of imagery used during a strength training program. The subscales consisted of three different types of imagery: appearance, motivational, and motor imagery. Appearance imagery is when a person pictures themselves having an athletic body, whereas motivational imagery is used in order to get one excited for the lift (Folland & Williams, 2007; Gammage, Hall, & Rodgers, 2000; Lebon et al., 2010; Silbernagel et al., 2007). The subscale of appearance imagery is utilized the most by exercisers, followed by motor imagery, and motivational imagery respectively (Monrue-Chandler et al., 2004; Newsom, Knight, & Balnave, 2003; Smith, Collins, & Holmes, 2003). However, Munroe-Chandler et al. did not assess which type of imagery resulted in the greatest strength gains or consider athletes as a part of their population. Although an understanding of what type of imagery exercisers were using was established, the physiological effectiveness of each imagery technique was failed to be examined.

The results from the Munroe-Chandler et al., study may not apply to the athletic population as athletes tend to engage in strength training for different reasons than recreational exercisers (Silberbagel et al., 2007). However, Silbernagel et al. found a similar result to Munroe-Chandler et al., when investigating the perceived effectiveness and type of imagery Division I College athletes used during their strength training programs. Silbernagel et al., found that appearance imagery was the most used form of imagery, and it was perceived as having the highest level of effectiveness. Although appearance imagery was the most utilized form of imagery in this study, it is from a third person perspective. This perspective is known to be ineffective at enhancing strength performance outcomes (Ranganathan, Kuykendall, Siemionow, &Yue, 2002). Therefore, strength performance was still not considered. Additionally, neither Silbernagel et al. nor Munroe-Chandler et al. assessed the imaging ability of the participants. Imaging from a visual perspective is easier than imaging from a kinesthetic perspective (Gregg et al., 2007). Therefore imaging ability may attribute to appearance imagery being used more than motor imagery, as motor imagery relies heavily on one’s kinesthetic imaging ability (Gregg et al., 2007). This further establishes the importance of using an appropriate structured motor imagery program. Additionally, the imager must possess sufficient motor imagery ability. Failing to assess the effects of the different imagery techniques on strength performance does not allow one to infer the type of imagery that will have the greatest impact in sport or strength performance.

2.7 MOTOR IMAGERY AND STRENGTH TRAINING

Recent research suggests that motor imagery can be used in combination with strength training to increase the potential benefits of the program (Lebon et al., 2010; Reiser et al., 2011; Reiser, 2005). Yue and Cole (1992) were the first to extend the use of mental training to the field of strength training in the form of motor imagery. Motor imagery was found to have a significant effect on isometric force production of the little finger. Not only was there a comparable increase between the motor imagery (22%) and maximal voluntary contraction group (29.8%) in the “trained finger”, but the contra lateral finger within the motor imagery group also had an increase in isometric force production. This highlights the importance of the central neural process in strength production and the training effect motor imagery can have on these processes. Reiser also demonstrated an increase in strength performance when using motor imagery. There was a 5.7% increase in an isometric bench pressing task suggesting that motor imagery not only effects singular or small muscle movement but, large multiple muscle actions as well.

The primary reason for an increase in isometric force production is not fully understood, however some propose it may be a result of increased motor programming, and/or increases in neurological adaptation of the muscle (Lebon et al., 2010; Ranganathan, 2004; Reiser et al., 2011; Reiser, 2005; Smith et al., 2003; Wright & Smith, 2009; Zijdewind et al., 2003). Motor imagery is known to stimulate the neurological pathways to the motor unit and spinal cord. Research has shown through the use of EMG that the neurological pathways are active when using motor imagery without the presence of physical movement (Folland & Williams, 2007; Gabriel et al., 2006; Ranganathan, 2004; Reiser et al., 2011;

Reiser, 2005). This suggests the presence of a physical stressor is not needed to promote strength gains.

It is well documented that prolonged periods of muscular immobility result in strength losses (Baechle & Earle, 2008; Newsom et al., 2003). However, motor imagery has been found to significantly reduce these losses (Horobayi et al., 2000; Mulder et al., 2006; Newsom et al., 2003). Previously, motor imagery was used in instances of immobility due to injury, and not a planned taper phase within a structured training program. Therefore, one could infer the use of motor imagery during the taper phase may result in a greater increase to strength performance.

Recently Reiser et al. (2011) conducted a study with 43 healthy sport students. The subjects participated in a 4 week standardized strength program using sub maximal loads followed by 4 weeks of combined strength training and motor imagery. A variety of motor imagery to strength training combinations were used (0%, 25%, 50% and 75%), as well as the control group that received no motor imagery or strength training. All of the groups receiving the motor imagery intervention had greater isometric strength gains than the control group. The group which received only strength training had the greatest increase in isometric strength (8%), however the motor imagery groups were only slightly lower (2.6-5%) following the 4 week motor imagery intervention phase. Reiser et al., concluded motor imagery is able to sufficiently replace strength training over a short period of time. However, a possible limitation of this study is the intensity of the standardized strength training and length of the motor imagery intervention phase. Using sub maximal loads would not promote significant gains to maximum strength (Baechle & Earle, 2008; Bompa & Haff, 2009; Issurin, 2010). Additionally, sub maximal loads would be unable to promote the typical strength rebound effect seen during a taper phase after periods of high intensity strength training (Baechle & Earle, 2008; Bompa & Haff, 2009; Issurin, 2010).

The length of the motor imagery intervention phase could potentially promote loss of strength or detraining, as periods of inactivity lasting as little as two weeks can result in a detraining effect. Therefore a period of inactivity longer than two weeks could possibly account for a lower percentage of gains seen in the motor imagery groups. A structured periodized strength training plan, which had a high intensity training phase prior to the decrease in volume, may result in more favourable conditions. This would allow one to determine the impact of motor imagery on strength during a taper phase prior to athletic competition.

2.8 GAPS IN THE MOTOR IMAGERY STRENGTH TRAINING RELATIONSHIP

To date, no known study has assessed the effects of motor imagery on dynamic strength performance. Even though large muscle group force production has been examined, all studies to date have used an isometric test (Ranganathan, 2004; Reiser, 2011; Reiser, 2005; Zijdewind et al., 2003). Using a dynamic strength test is needed to allow a better understanding of how motor imagery may transfer to sport performance. Another gap in the literature is that no known study has examined the use of a motor imagery program in combination with a structured strength training program. This again prevents one from understanding the impact motor imagery can have on dynamic strength. Reiser et al., suggest the next focus within the field of combining motor imagery and strength training is the design of studies which closely represent actual training practice (i.e., structured periodization and dynamic strength training). This will allow one to understand the transferability of motor imagery to athletic or skilled movements.

2.9 CONCLUSION

Motor imagery has been shown to increase the isometric force production of both small and large muscles. Reiser et al. (2011) suggests motor imagery could be used to increase the training effects during training periods of high neural activation such as maximum strength, plyometrics or power phases. However, the effect of motor imagery and strength training during a periodized training program on dynamic strength performance has yet to be established. Given this gap in the literature, further research is needed which investigates the impact motor imagery has on neurological adaptations and dynamic strength performance (Lebon et al., 2010; Reiser et al., 2011).

The amount, type, and effectiveness of general imagery as a part of an athletes' exercise program has been well documented, however less has been studied on the effect of motor imagery. The literature has revealed participants perceived appearance imagery to be the most used and effective form of imagery in exercise (Munroe-Chandler et al. 2004; Silbernagel et al., 2007). However, promoting appropriate imagery guidelines or assessing the ability of the imager was not done in either of Silbernagel et al. or Munroe-Chandler et al. studies. Creating a program based on Holmes and Collins (2002) PETTLEP model would provide the structure needed to achieve strength performance gains from motor imagery (Ranganathan et al., 2002; Reiser, 2005; Smith et al., 2003; Wright & Smith, 2009; Zijdewind et al., 2003). Additionally, neither Silbernagel et al. nor Munroe-Chandler et al. assessed strength performance. Therefore, further investigation assessing whole body strength gains in conjunction with the perceived motor imagery effectiveness is needed to fully establish the relationship between strength training and motor imagery. This would develop a better understanding of strength training, and allow athletes to maximize one's potential strength training program.

The current study examined the effects of motor imagery use during an 11 week periodized strength program, as well as the effects on a one week taper phase. Based on the current body of literature on motor imagery, and findings of Reiser et al. (2011) and Lebon et al. (2010) it was hypothesized that the use motor imagery would result in greater strength gains overall. Additionally the motor imagery group would also have a larger rebound effect during the one week taper phase.

CHAPTER 3 METHODOLOGY

3.1 PROCEDURES AND STUDY DESIGN

This study was a two-armed randomized controlled trial that compared the effects of a motor imagery intervention group versus a motivational music placebo group on strength performance of the upper and lower body. All participants engaged in an 11 week strength training program. Over the course of the 11 week program, four testing and 30 strength training sessions were completed. This study was reviewed and approved by the Dalhousie University Research Ethics Board.

Participant recruitment commenced July 25th 2012 and entailed several strategies to identify participants. Following facility approval (Appendix A), posters (Appendix B) advertising the study were placed throughout the Dalplex fitness facility at Dalhousie University, the CSCA, Sport Nova Scotia, and the Canada Games Center. Additionally, through contacts in the community, at the CSCA and Sport Nova Scotia the study was promoted to exercise physiologists, sport psychologists, coaches and managers of teams with athletes who met the appropriate criteria. This was done by emailing a one page letter which briefly outlined the purpose of the study and potential benefits and risks for their athletes (Appendix B). All training and testing sessions took place within the CSCA. The CSCA was chosen as the intervention site as it caters to high performance athletes, had the necessary training equipment, and is centrally located within the Halifax region.

Prior to participation, eligible participants provided written informed consent (Appendix C). For those athletes under the age of consent, parental informed consent, and participant assent were obtained (Appendix C). The Physical Activity Readiness Questionnaire (PAR-Q; Canadian Society of Exercise Physiologist (CSEP), 2002), and liability waiver from the CSCA were also completed prior to any fitness testing or strength training (Appendix D). The PAR-Q is a test commonly used in any fitness related research or testing to ensure safety and assess any possible risk of exercising an individual may have (Baechle & Earle, 2008). This questionnaire provided a health history of the participant, using general questions based on pain, dizziness, and cardiovascular function (CSEP, 2002). Finally, all participants completed the Movement Inventory Questionnaire-Revised (MIQ-R; Hall & Martin, 1997; Appendix E) and achieved a mean score of 3.0 on a scale of 1 (very easy to image) to 7 (very difficult to image) as an additional cut off criterion for participation (Reiser et al., 2011).

Eligible and consenting participants were then randomized into either the treatment (motor imagery) or placebo (motivational music) condition. The strength training intervention consisted of three main phases (for full strength training programs refer to Appendix F): (1) Familiarization Training Phase; (2) Strength Training Phase; and (3) Taper Training Phase (Figure 1). The familiarization training phase lasted a total of two weeks while the strength training phase and taper training phase lasted eight weeks and one week respectively. To aid in preventing the diffusion of the motor imagery or motivational music intervention, all participants in the motor imagery group trained together and the participants in the motivational music group trained together at a time different from the previous group. Upon conclusion of the intervention the participants were asked to engage in a fifteen minute exit interview. Prior to engaging in the exit interviews, the participants were given another separate consent or parental consent form (Appendix C).

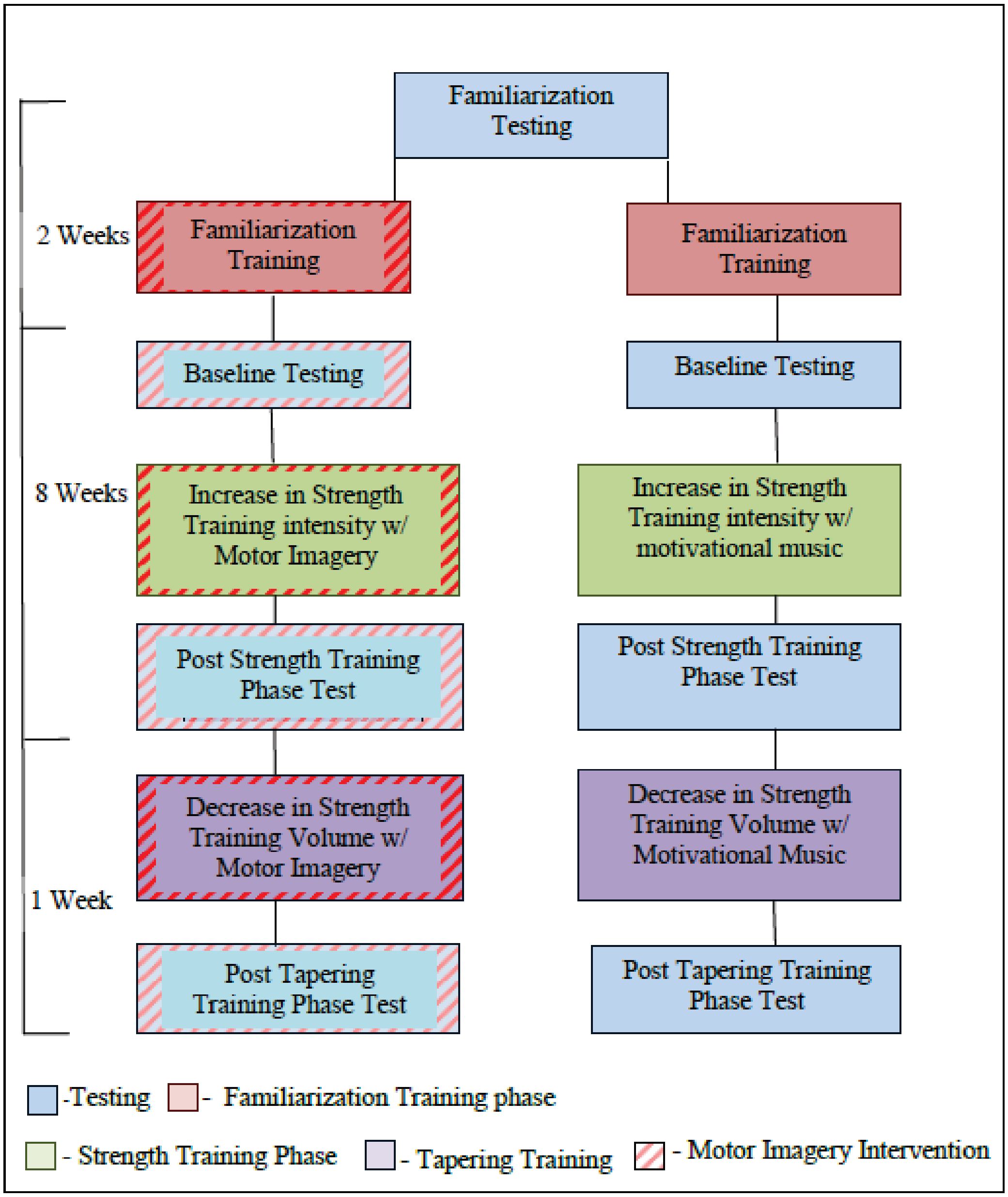

Figure 1 Overall study design and layout for each group.

Data were collected through familiarization, pre/post-strength, and post-taper testing (Appendix F) using a variety of descriptive variables, anthropometric and strength measurements, and the MIQ-R (Appendix E) (Hall & Martin, 1997). Before engaging in the testing protocol, participants were advised to adhere to an appropriate pretest protocol. Participants were instructed to: (1) not to exercise within 24 hours of testing session; (2)

ensure proper hydration status (8-12 cups of liquid the day prior to testing); as a guideline, participants were asked to ensure that there was an opaque coloration to their urine; (3) ensure adequate daily nutrition by following the Canada Food Guide recommendations; and (4) not to eat within 1 hour prior to testing, due to the risk of vomiting or decreased performance (Baechle & Earle, 2008).

3.1.1 Participants

To be eligible for this study the participants had to: (1) be between the ages of 15-24 years; (2) not received additional strength training from any outside sources other than this study for the 11 week duration of the trial (September 2012- December 2012); (3) have engaged in sport at a "competitive level" for a minimum of two years; and (4) not been withdrawn (e.g., quit or injury) from their sport for over one year. For the purpose of this study "competitive level" was defined as participation in sport where the primary focus is winning and the participants engage in deliberate practice (e.g., junior level hockey player) (Baker & Côté , 2006; Corbeil, 2000; Côté , 1999). In addition to the above criteria, participants must have scored a 3.0 or less on the MIQ-R (Reiser et al., 2011). To establish the 3.0 minimum for the subscales, both the kinesthetic imagery and the visual imagery were summed and an average of the two was taken (Reiser et al., 2011). The combination of the two MIQ-R subscales was done in order to stay consistent with other research in the field of motor imagery and strength training (Reiser et al., 2011; Reiser, 2005).

The minimum criteria of a 3.0 on the MIQ-R ensured that the participants' motor imagery ability did not significantly impact the outcome measures. Participants were excluded if the athlete had any medical or physical limitations that would have precluded their safe participation (e.g., ongoing injury or heart disease). The participant's readiness to participate was assessed by the PAR-Q (CSEP, 2002; Appendix D).

Since participants were restricted from strength or physical training outside the current study, recruitment proved to be very challenging. Since the strength training portion of this study was developed using the model of linear periodization (Baechle & Earle, 2008; Bompa & Haff, 2009; Issurin, 2010), any additional training may have resulted in an increased risk of overtraining, or altered the outcome measures (Baechle & Earle, 2008). While there was the possibility of excluding participants whose sport required them to participate in additional strength training, the training protocol for this study was designed to replace any extra strength training a sport may require. The participant age criterion was based on the long term athlete development (LTAD) model. The LTAD identifies athletes greater than the age of fifteen participating in competitive sport in the training to compete or training to win stage (Bayli & Hamilton, 2003; Forad, et al., 2011). Before this marker on the LTAD athletes primarily train to establish a base level of strength, other physiological attributes within the body and general movement technique. Additionally, recreational athletes were excluded from participation, because they are considered to be in the active for life stage of the LTAD (Bayli & Hamilton, 2003; Forad, et al., 2011). As such, an active and healthy lifestyle is the primary focus of this stage, not maximal performance (Bayli & Hamilton, 2003; Forad, et al., 2011). Since this study was aimed at maximizing strength performance, and in turn sport performance, the defined age range and competitive level of athlete appeared to be appropriate.

3.1.2 Sample Size Calculation

To calculate the required sample size, the principal investigator (PI) looked to a recent study by Lebon et al., (2010). This study explored the combined effects of motor imagery and a strength program on maximal voluntary muscle contraction during a bench and leg press. Based on a moderate effect (Cohen, 1988), a total sample of 28 participants (n=14/group) was deemed to allow sufficient power (80%) to detect a difference in dynamic strength production in the upper and lower body ($\alpha = 0.05$). To account for a (20%) participant attrition (Lebon et al., 2010) over the eleven week study duration, an extra 6 (n=3/group) participants were deemed necessary. Therefore the PI started recruiting with the goal of reaching 32 (n=16/group) participants.

3.1.3 Random Assignment to Groups, Allocation Concealment, and Randomization Implementation

Consenting participants were separated into separate stratums based on gender. This was done to ensure equal representation of gender within the placebo and intervention conditions. This was necessary, as men and women have different responses to strength training, for example men have a greater increase in muscle fiber size than women (Ivey et al., 2000; Miller et al., 1993). After separating the sample by gender one male and one female were randomly assigned to either the intervention or placebo condition in a 1:1 ratio using a computer-generated allocation sequence. This promoted equal representation of gender for each group. The allocation sequence and group assignments were generated by a member of the research committee. The committee member was blinded to any descriptive characteristics of the participants other than sex. The PI did not conduct any of the randomization-related procedures.

3.2 INTERVENTION

All strength training sessions were supervised by either the PI or a trained research assistant (RA). All testing sessions were conducted by the same RA who was blinded to group allocation. The PI and all RAs were Certified Strength and Conditioning Specialist (CSCS) and had currently held or were working towards a Master's of Science in Kinesiology.

The strength training done throughout the intervention followed that of structured periodization (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Issurin, 2010; Plisk & Stone, 2003). This was done to mimic an athlete's strength training prior to a competition. Although a periodized structure was used no other research in the field of motor imagery has done a study of this length (11 weeks). The study had three main phases: the familiarization training phase, strength training phase, and taper training phase (Appendix F; Figure 1). The participants began the study with a familiarization-test (Appendix G), followed by the two week familiarization training phase. The primary goal of the familiarization phase was for the participants to become comfortable and familiar with the test battery and strength training. This promoted test, re-test reliability and prevented participant familiarity with testing protocol from impacting the outcome measures (Altman & Bland, 1983). The use of the familiarization training phase also permitted the PI to make any exercise technique corrections or adjustments. This ensured the participant achieved optimal strength benefits throughout the strength training intervention.

During the familiarization training phase the motor imagery group also participated in a 10 to 20 minute motor imagery educational session (Appendix H) prior to their strength training session. This session included a brief description of motor imagery and focused on the development of proper motor imagery technique. The educational sessions were also used to outline the muscles involved for each movement. This allowed for the participants to have a working understanding of where to focus their imaging efforts for a given exercise (e.g., the hamstring, quadriceps and gluteal activation during the back squat). In addition to motor imagery sessions prior to the strength training, participants completed one set of motor imagery for four repetitions per exercise after executing each physical set of the exercise throughout the familiarization training phase (Appendix F). Participants allocated to the music placebo group did not receive any additional instruction. However both groups had access to music.

After the familiarization training phase (Appendix F), all participants engaged in baseline testing (Appendix G). This enabled the researcher to capture any change in strength performance during the familiarization sessions and establish a baseline measure of upper and lower body strength. Following the second round of testing, the participants began the strength training phase. The strength training phase lasted a total of eight weeks and utilized structured linear periodization for maximum strength gains (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Plisk & Stone, 2003). The initial three weeks of the strength training phase focused on muscular endurance and muscular hypertrophy. The fourth week was an adaptation week. This allowed the participants to recover from the previous four weeks of training. This ensured the participants were able to endure the demands of the final four weeks which focuses on maximum strength (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Plisk & Stone, 2003). This type of strength training has a high neurological demand, which may result in an increased risk of fatigue (Baechle & Earle, 2008). During the maximum strength portion of the strength training phase, an intensity of

80-90% 1RM was used. This high level of intensity was designed to promote positive strength performance outcomes (Baechle & Earle).

Throughout the eight week strength training phase, motor imagery was executed by the intervention group during the rest periods between exercise sets. One set of four repetitions of maximal muscle contraction for each exercise were imaged following the physical set of the movement (Reiser et al., 2011; Reiser, 2005). For example, a participant would complete six repetitions of back squat and then immediately image one set of four repetitions of the back squat. The motor imagery group also received four additional motor imagery educational sessions in weeks 4, 6, 7 and 9 (Appendix H). These sessions ensured the participants had a suitable understanding of motor imagery techniques and allowed the PI to make any changes needed. This included: adjusting participant focus, further explanation of muscles involved in the exercises, ensuring participants were able to stimulate all senses in throughout the participant's imaging.

After the strength training phase, all participants underwent another testing session to assess their post training strength. Following the post-strength testing session all the participants started the final taper phase. Research has established the use of a tapering phase prior to a major athletic competition results in the maximization of performance (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Issurin, 2010; Plisk & Stone, 2003). The taper training phase followed that of a traditional taper, with a reduction in training volume, but maintenance of training intensity (%1RM) lasting one to two weeks (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Issurin, 2010; Plisk & Stone, 2003). Therefore, the participants had a decreased strength training volume of two sessions for one week, as well as a decreased number of sets done for each exercise (e.g., during the strength training phase five sets of back squats were executed, but the number of sets during the taper phase were reduced to two sets).

Both the placebo and intervention groups received the same strength training during the taper phase. However, the motor imagery group was instructed to image an additional three sets of four maximal muscle contraction repetitions for each exercise (e.g., back squat) (Ranganathan et al., 2004; Reiser et al., 2011; Reiser, 2005; Zijdewind et al., 2003). The number of sets imaged was set to replace any reduction in physical training volume which occurred as a result of the taper training phase (e.g., there were 5 sets of back squat executed in the final week of strength phase but, only 2 sets during the taper phase). Therefore, the motor imagery group imaged 3 sets of back squat with 90 seconds of rest between each image set. The placebo group only engaged in the strength training and listening to music protocol, and did not receive any additional stimulus to the muscle.

Post-taper measures were taken at the end of the taper phase (i.e., 11th week). This allowed for a comparison of both the relative effect motor imagery had on strength performance throughout the taper training phase, as well as, the relative effect motor imagery had on baseline strength measures, following a simulated structured strength training plan. Upon the conclusion of the entire intervention, participants completed a study debrief form (Appendix I).

3.2.1 Motor Imagery Sessions

Consistent with other research done in the field of motor imagery, this study looked to the Holmes and Collins' (2002) PETTLEP model to develop the motor imagery intervention (Lebon et al., 2010; Ranganathan et al., 2002; Reiser, 2005; Reiser et a., 2011; Zijdewind et al., 2003). Each of the instructional motor imagery sessions (Appendix H) was guided by auditory cues, which aided the motor imagery capabilities of the participants (Zijdewind et al.). These sessions ranged from 10 to 20 minutes. The participants kept their eyes open or closed while imaging each exercise and muscular contraction. They were also encouraged to utilize a kinesthetic perspective when imaging (Ranganathan et al., 2002). The PI reminded the participants through the use of cue words for each exercise to promote proper motor imagery technique. The PI also visually monitored the participant for physical muscle contractions. This method of monitoring was found reliable by Reiser (2005). Additionally, it has been shown that participants are able to follow motor imagery instructions with physical muscular movement levels near zero. This indicates inactive muscles during motor imagery training (Ranganathan et al., 2002; Yue & Cole, 1992).

Research has indicated that motor imagery is most effective when it is individualized for the participant (Wilson, Smith, Burden, & Holmes, 2010). This reinforces the importance of having an individualized motor imagery intervention for the participants. To establish an individualized motor imagery program for each participant, they were asked to image the maximal load lifted throughout the study. Finally, the intervention group imaged immediately after each physical set. The motor imagery was executed at this time because the combination of mental and physical practice would provide the greatest response (Savoy & Beitel, 1996; Vogt, 1997). Additionally, this further promoted optimal conditions to mimic physical practice (Vogt, 1997). Finally, music was playing in the background throughout the strength training and motor imagery intervention.

Upon the conclusion of each strength session throughout the study the intervention group was asked to rate the perceived effectiveness of their motor imagery uses (Appendix H). This was done on a scale of 1 (no image could be performed at all) to 5 (Vivid image could be performed) (Reiser et al., 2011; Reiser, 2005). The motor imagery group was also asked to rate the vividness of their upper and lower body motor images on the same 1 (no vivid imagery was performed) to 5 (extremely vivid image was performed) (Reiser et al., 2011; Reiser, 2005). Finally, the participants in this group were asked how often they imaged throughout the strength session. The answers to these questions were written on a sheet of paper provided by the PI or RA (Appendix J).

3.2.2 Motivational Music Sessions

During the training sessions for the placebo (motivational music) group, each participant had the option to listen to their own self-selected music or listen to the motivational music provided by the PI. The music was listened to throughout the entire session, and could be changed at any time. The same playlist was not used for each session (unless the participant self-selected their music). This ensured the participants did not become bored listening to the same music over and over. At the end of each of the strength training sessions participants were asked to rate the perceived motivational effectiveness of the music on a 5-point scale (1-not effective) to (5-extremely effective) (Appendix J).

3.3 MEASURES

Demographic variables included the age, sex, sport, and level of sport competition. The *Anthropometric* measurements included body height and weight, muscle girth, and percentage of body fat (Baechle & Earle, 2008). Throughout the anthropometric measurement portion of the assessment session the participants were required to remove their shoes, and wear minimal dry gym clothing (e.g., t-shirt and shorts). Measurements of height and weight were taken in centimeters and kilograms, respectively. The participants' height was measured using a standiometer (Baechle & Earle, 2008) and a certified balance scale was used to assess participant weight (Baechle & Earle, 2008). Girth measurements were taken throughout using a pliable measuring tape, this enabled the tester to easily encompass a given body part (Marfell-Jones, Olds, Stewart, & Lindsey-Carter, 2007). Each measurement was taken to the nearest millimeter and was taken before any other strength tests were performed. This prevented the possibility of exercise induced swelling within the muscle due to increased blood, or other fluid flow to the active site, or alterations to body hydration status (Baechle & Earle, 2008). If the participant requested, all anthropometric measurements were taken in a private room at the CSCA facility. Finally, percent body fat was assessed using a bioelectrical impedance analysis (BIA). The BIA has been used by many clinical and research studies as it is a fast, non-invasive, and reliable way to give an estimation of fat mass (Jaffrin, 2009; Vicente-Rodrequez, et al., 2012). As the BIA can be affected by one's hydration level, all participants were asked to hydrate appropriately prior to all testing sessions.

Strength was measured using the three repetition maximum (3RM) bench press and back squat tests. The 3RM tests assessed the maximum exertion a muscle group can produce in three movements (Baechle & Earle, 2008; McCurdy, Langford, Cline, Doscher & Hoff, 2004). The 3RM tests are reliable, inexpensive, and reflect a similar dynamic process necessary for sport movement (Baechle & Earle, 2008; McCurdy et al., 2004). These tests are used by strength and conditioning professionals, as well as researchers when assessing maximum strength related measures (Berg, Latin, & Baechle, 1992; Henschen, 1993; Heyward, 2002). A 1RM was not used due to the complex nature of the bench press and back squat a true 1RM can be difficult to achieve and possibly increase the risk of injury (Baechle & Earle, 2008).

The 3RM bench press was assessed using a bench press apparatus and 11kg, 15kg or 20kg bar. Any necessary weight the participant required was then added. For the 3RM back squat test, the same bars and loading protocol was used, in addition to a squat rack. In order to accurately assess the bench press and back squat 3RM, each participant was allowed to warm up by executing each movement at a comfortable weight (e.g., 25% of their estimated 3RM), after the warm up the participant started at (50%) of their estimated 3RM, if the movement was executed successfully they repeated the test after an appropriate rest interval (1-5 min) (Berg, Latin, & Baechle, 1992; Henschen, 1993; Heyward, 2002). The amount of time needed to rest was dependent upon the difficulty of the previously executed movement. The difficulty of the test also determined how much weight should be added in the next trial. This method was used for both the 3RM bench press and back squat tests. Both of these tests were done during the same testing session as they stress different muscles within the body, and fatigue from the previous exercise was not a factor (Berg, Latin, & Baechle; Henschen; Heyward). Lastly, as there are a variety of changes which can arise throughout different times of the day (e.g., hydration status, height, weight, muscle swelling) all testing was done at the same time of day (e.g., 1:00 pm) (Baechle & Earle, 2008).

Motor imagery was assessed using the MIQ-R (Hall & Martin, 1997; Appendix E). The MIQ-R is a standardized questionnaire which assesses one’s ability to image movement. This instrument examined the participants’ ability to visualize (visual sense) and feel (kinesthetic sense) the image of eight different movements. This questionnaire was done by first asking the participant to physically execute the movement. After which the participant imaged the same movement and provided a rating from 1 (very easy to see or feel) to 7 (very difficult to see or feel). In order to provide an accurate value for a given experience, the participants were allowed as much time as needed and could give the same scores for multiple movements (Hall & Martin, 1997). The internal consistencies of the MIQ-R are adequate with Cronbach alpha coefficients ranging above (0.79), for both visual and kinesthetic subscales reported by Abma et al. (2002) and Monsma and Overby (2004), as cited in Gregg et al. (2007). The alpha values for the visual and kinesthetic subscales in this study were 0.833 and 0.871 respectively. The alpha value for the combination of both visual and kinesthetic subscale was 0.878.

Exit Interviews were completed after the final testing session. The interviews were approximately fifteen minutes in length and consisted of three open ended questions. The questions asked were: (1) did you find the use of (motor imagery or motivational music) improved or hindered your exercise technique? (Why? How? What aspects?); (2) did you find the use of (motor imagery or motivational music) aided/hindered in increasing your upper/lower body strength, or both? (Why did you think it affected it? Could you feel a difference? How?); and (3) did you find it easy to use (motor imagery or motivational music) throughout the study (What was? How was it? Examples?) These questions were used for both the motor imagery and placebo groups. Lebon et al. (2010) used a similar exit interview design when examining the effects of motor imagery on maximal voluntary muscle contractions of the bench and leg press. Lebon et al. found the exit interviews supported and added to the quantitative data set. Therefore, it was the hope of the PI that the exit interviews would provide further information on the effects of motor imagery or motivational music on strength performance.

3.4 STATISTICAL ANALYSIS

Descriptive statistics were used to examine the demographic and fitness variables of the sample. Independent sample t-tests were done to ensure there was no significant difference between the placebo and intervention group's baseline measures. Mixed between-within repeated measures Analysis of Variance (ANOVA) were completed to analyze the between group, as well as within group differences in: strength performance, imaging ability and the participants' change in perceived effectiveness of the imagery quality for the upper and lower body, as well as how often one used imagery across the different time periods. For the repeated measures ANOVA, sphericity was tested for and identified using the Wilks-Lamba output. If sphericity was not violated tests of the within-subject was used. If sphericity was violated, the multivariate output was used. Significance was found on calculations with a p-value less than 0.05. A post-hoc analysis was completed to further investigate any significance from the repeated measures ANOVA.

Effect sizes (partial eta squared:η_p^2) were also examined. The following guidelines were used to interpret the effect size values: a small effect equals 0.01, medium effect equals 0.06 and a large effect equals 0.14 (Cohen, 1988). Effect sizes were investigated because this study was aimed to have practical relevance and participant recruitment goals were not met.

A regression analysis was computed for MIQ-R scores and the change from baseline to post taper strength performance. Finally, the exit interviews were analyzed for general content and comments expressed by the participants. A category was included if even one person has expressed an idea (Miles & Huberman, 1994; Sandelowski, 2010). The identification of categories was used to support the quantitative data found.

CHAPTER 4 RESULTS

4.1 PARTICIPANTS

A total of 24 participants were recruited, five participants withdrew prior to the first testing session due to the time commitment. Three dropped out after the two week familiarization phase due to transportation issues, and one participant dropped out after agitating a pre-existing injury. This participant was screened by the PAR-Q and received approval to participate, but the demands of the program were perceived to be too much by the participant. Therefore a final sample of 15 participants (n= 12 females, n= 3 males) (n= 8 for intervention group and, n= 7 for placebo group) completed the requirements of this study. Two participants within the motor imagery group reported feeling back fatigue and muscle soreness during the post-taper testing session. The motor imagery group make up consisted of seven females and one male, while there were five females and two males within the placebo group. There was no significant difference (p>0.05) between groups for all baseline measures (Table 1).

Table 1 Baseline Measurements of the Motor Imagery and Placebo Groups

Measure	Motor Imagery		Placebo		Between Group
	M	SD	M	SD	*p*
MIQ-R	3.0	0.5	2.5	1.0	0.130
Back squat (*kg)*	82.9	29.7	84.6	20.3	0.990
Bench press (*kg)*	43.5	18.7	45.0	15.5	0.970
Height *(cm)*	163.9	8.5	165.9	4.1	0.580
Weight *(kg)*	74.0	21.7	63.4	4.9	0.230
BMI *(kg/m^2)*	28.0	10.4	23.0	0.9	0.230
Body fat *(%)*	31.3	10.0	24.1	8.2	0.160
Relaxed Bicep *(cm)*	30.8	6.3	27.5	1.9	0.200
Flexed Bicep*(cm)*	38.7	16.9	29	2.4	0.160
Chest *(cm)*	94.6	14.0	87.6	3.0	0.210
Waist *(cm)*	82.7	17.4	75.1	3.7	0.280
Hips *(cm)*	102.9	11.4	95.7	3.1	0.130
Thigh *(cm)*	53.4	5.7	51.3	3.0	0.390
Calf *(cm)*	37.6	4.0	35.5	1.1	0.190

Note: MIQ-R scores are from the 7-point Liekert scale

4.2 POST INTERVENTION STRENGTH MEASURES

No significant differences between post strength and all post taper anthropometric measurements between the placebo and motor imagery groups were found ($p>0.05$) (Table 2). The post strength phase back squat and bench press scores for motor imagery group were, (*M*=118.8, *SD*= 35.2) (*M*= 56.6, *SD*= 24.2) respectively. The post strength phase back squat and bench press scores for the placebo group were (*M*=110.0, *SD*= 23.4, and *M*=55.5, *SD*=18.8) respectively. There was no significant difference between either of the post strength phase back squat or bench press scores (*p*=0.570) and (*p*=0.930) between the two groups.

Table 2 Post-Taper Anthropometric Measurements of the Motor Imagery and Placebo Groups

Measure	Motor Imagery		Placebo		Between group	Within group
	M	SD	M	SD	*p*	*p*
Height *(cm)*	167.6	6.8	165.7	3.9	0.53	-
Weight *(kg)*	76.8	21.9	64.1	4.5	0.16	-
BMI *(kg/m^2)*	27.0	5.7	23.3	0.9	0.12	-
Body fat *(%)*	29.8	10.3	20.7	7.9	0.08	-
Relaxed Bicep *(cm)*	31.6	5.8	29.0	2.5	0.29	-
Flexed Bicep*(cm)*	33.1	6.3	29.6	2.2	0.19	0.060
Chest *(cm)*	94.6	12.1	88.6	2.8	0.23	0.590
Waist *(cm)*	83.2	17.1	78.6	7.0	0.52	-
Hips *(cm)*	101.9	11.1	96.5	2.7	0.24	0.150
Thigh *(cm)*	55.7	5.2	51.8	3.2	0.11	0.120
Calf *(cm)*	37.1	5.0	35.9	1.3	0.57	0.410

The post taper phase back squat and bench press scores for the motor imagery were (*M*=122.5, *SD*= 35.0 and *M*= 60.7, *SD*= 24.0) respectively. The post taper phase back squat and bench press scores for the placebo group were (*M*=119.3, *SD*= 24.6, and *M*=55.0, *SD*=17.9) respectively. There was no significant difference for either of the post strength phase back squat or bench press scores (*p*=0.840) and (*p*=0.620) between the two groups. Table 3 displays the change in measures between groups across the three testing periods.

Table 3 Results of Key Measurements at Post-Testing Sessions Compared to Baseline Measures

Test	Measure	Motor Imagery		Placebo		Between Group
		M	Change from baseline	M	Change from baseline	Percent difference
Baseline	BMI *(kg/m^2)*	28.0	-	23.0	-	--
	Body fat *(%)*	31.3	-	24.1	-	-
	MIQ-R	3.0	-	2.5	-	-
	Back squat *(kg)*	82.9	-	84.6	-	-
	Bench press *(kg)*	43.5	-	45.0	-	-
Post-Strength	BMI *(kg/m^2)*	26.9	-1.1	23.5	0.5	-
	Body fat *(%)*	33.4	2.1	24.1	0.0	-
	MIQ-R	1.5	-1.5	2.5	0.0	
	Back squat *(kg)*	118.8	35.9	110.0	25.4	7%
	Bench press *(kg)*	56.6	13.1	55.5	10.5	2%
Post-taper	BMI *(kg/m^2)*	27.0	-1.0	23.3	0.3	-
	Body fat *(%)*	29.8	-1.5	20.7	-3.4	-
	MIQ-R	1.5	-1.5	2.5	0.0	-
	Back squat *(kg)*	122.5	39.6	119.2	34.6	3%
	Bench press *(kg)*	60.7	17.2	55.0	10.0	10%

Note: MIQ-R scores are from the 7-point Liekert scale

4.3 DIFFERENCES IN STRENGTH PERFORMANCE BETWEEN GROUPS

A mixed between-within subject repeated measures ANOVA was conducted to assess the impact of the two groups, (motor imagery and motivational music) on scores of upper and lower body strength (bench press and back squat), across three time periods (baseline, post-strength, and post-taper) were examined.

4.3.1 Repeated Measures ANOVA Results for Lower Body

For the lower body results a significant main effect for time $F(2,15)=113.8$, $p=0.000$, $\eta_p^2=0.897$(large) was found showing an overall increase in lower body strength across the three time periods. An LSD post-hoc analysis revealed significance for this measure was found in both post-strength and post-taper measures. There was a non-significant interaction between program type and time $F(2, 15)=1.96$, $p=0.162$, $\eta_p^2=0.131$ (large).

The group main effect comparing the final strength outcomes of the two types of intervention was not significant $F(2, 15)=0.55$, $p=0.818$, $\eta_p^2=0.004$ (small), suggesting no meaningful difference in the effectiveness of the two training approaches for lower body strength. Figure 2 represents the change in back squat strength across the three testing periods.

4.3.2 Repeated Measures ANOVA Results for Upper Body

For the upper body strength a significant main effect for time, $F(2,15)=58.51$, $p=0.000$, $\eta_p^2=0.907$ (large) was found, showing an overall increase in upper body strength across the three time periods. An LSD post-hoc analysis revealed significance for this measure was found in both post-strength and post-taper measures. There was a significant interaction between program type and time, $F(2, 15)=12.57$, $p=0.001$, $\eta_p^2= 0.677$ (large). A post-hoc analysis revealed the motor imagery group had a mean change of ($M=4.075$, $SD=1.99$) between the post-strength and post-taper sessions. The placebo group had a mean change of ($M=-0.514$, $SD= 2.13$) between the post-strength and post-taper sessions. This difference in change was found to be significant ($p<0.05$) between the two groups. The bet group main effect comparing the final strength outcomes of the two types of intervention was not significant, $F(1, 15)=0.028$, $p=0.870$, $\eta_p^2=0.002$ (small), suggesting no overall difference in the effectiveness of the two training approaches for upper body strength. Figure 3 represents the change in bench press strength across the three testing periods.

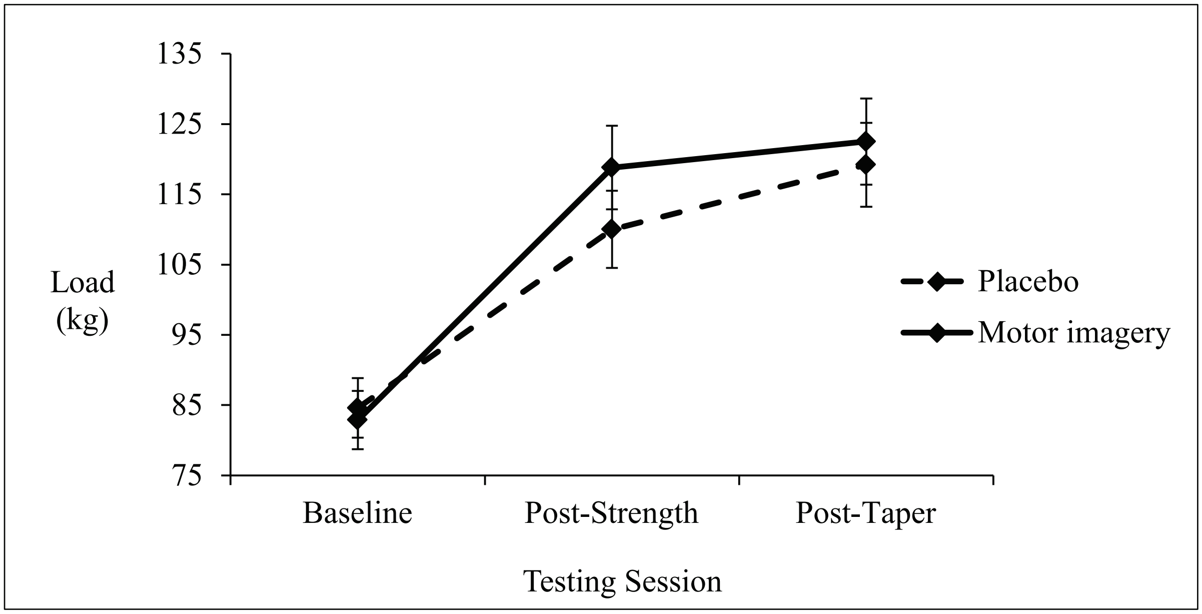

Figure 2 Bench press results for the motor imagery and placebo groups. Measurements were taken at baseline (motor imagery: *M*= 43.5 kg, *SD*= 18.65 kg; placebo: *M*= 45.0 kg, *SD*= 15.54 kg), ten weeks (post-strength; motor imagery: *M*= 56.6 kg, *SD*= 24.2 kg; placebo: *M*=55.5 kg, *SD*=18.8 kg) and eleven weeks (post taper; motor imagery: *M*= 60.7 kg, *SD*= 24.0 kg; placebo: *M*=55.0 kg, *SD*=17.9 kg). There was a significance increase in overall strength for both groups ($p=0.000$, $\eta_p^2=0.907$). There was no significant difference for the overall main effect ($p=0.870$, $\eta_p^2=0.002$). However significance was found for the interaction effect for program type and time ($p=0.001$, $\eta_p^2= 0.677$). (✦= where significance occurred for the interaction effect)

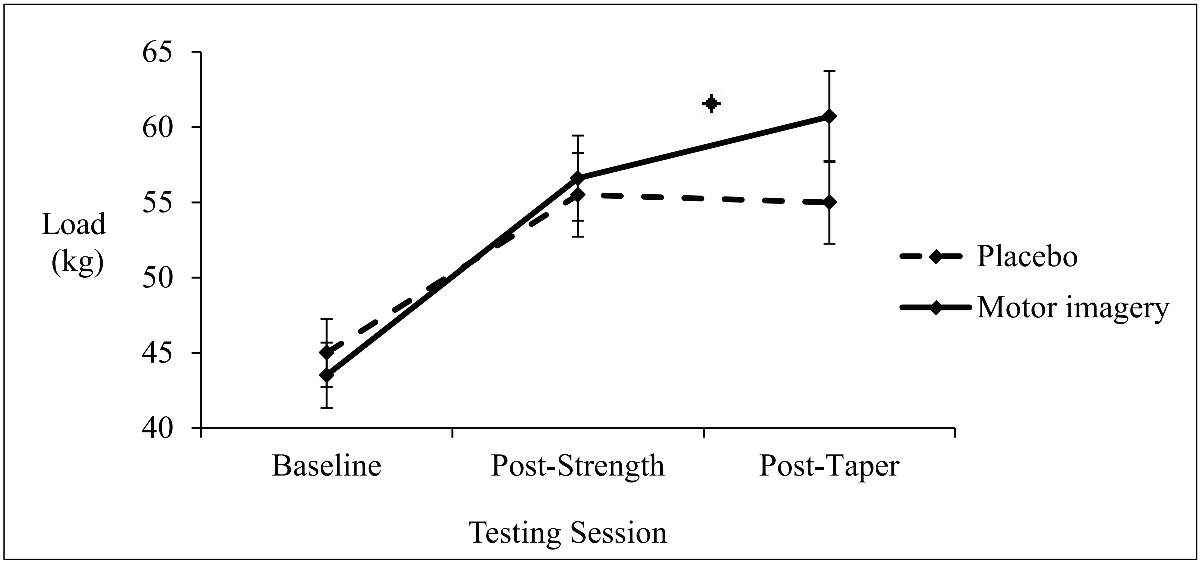

Figure 3 Bench press results for the motor imagery and placebo groups. Measurements were taken at baseline (motor imagery: *M*= 43.5 kg, *SD*= 18.65 kg; placebo: *M*= 45.0 kg, *SD*= 15.54 kg), ten weeks (post-strength; motor imagery: *M*= 56.6 kg, *SD*= 24.2 kg; placebo: *M*=55.5 kg, *SD*=18.8 kg) and eleven weeks (post taper; motor imagery: *M*= 60.7 kg, *SD*= 24.0 kg; placebo: *M*=55.0 kg, *SD*=17.9 kg). There was a significance increase in overall strength for both groups (p=0.000, η_p^2=0.907). There was no significant difference for the overall main effect (p=0.870, η_p^2=0.002). However significance was found for the interaction effect for program type and time (p=0.001, η_p^2= 0.677). (✦= where significance occurred for the interaction effect)

Figure 4 displays the change in back squat strength over the course of the intervention for each participant within the motor imagery group. Figure 5 represents the change in bench press strength over the course of the intervention for each participant within the motor imagery group. Individual plots were done due to the small sample size, and highlight the effect of motor imagery.

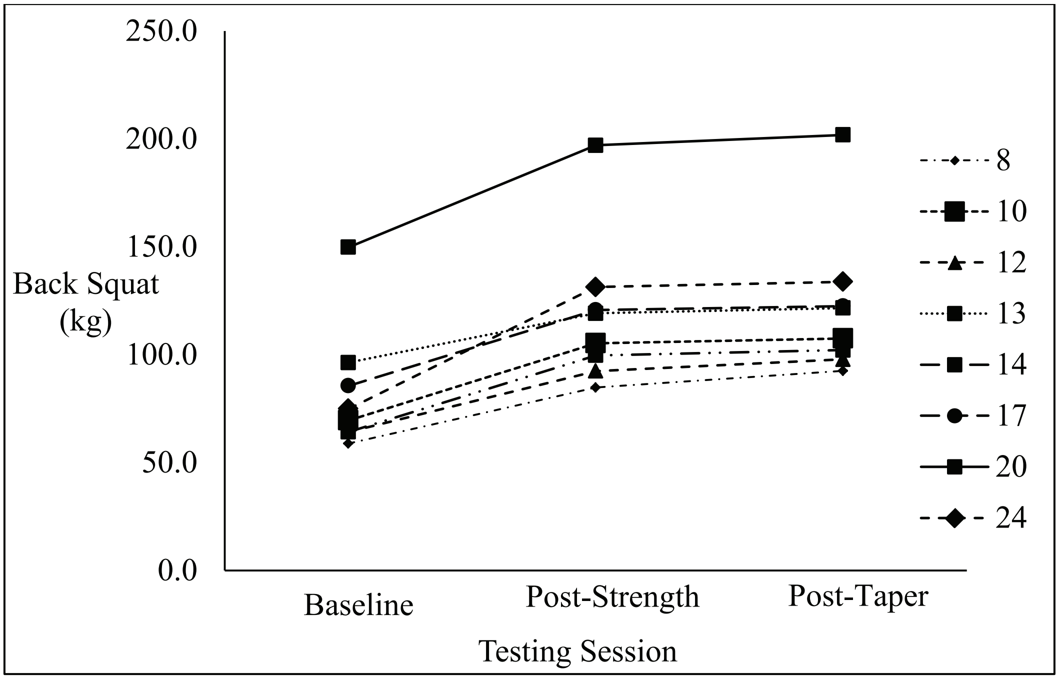

Figure 4 Displays the change in individual back squat strength for participants in the motor imagery group. All back squat weight is in kilograms (kg).

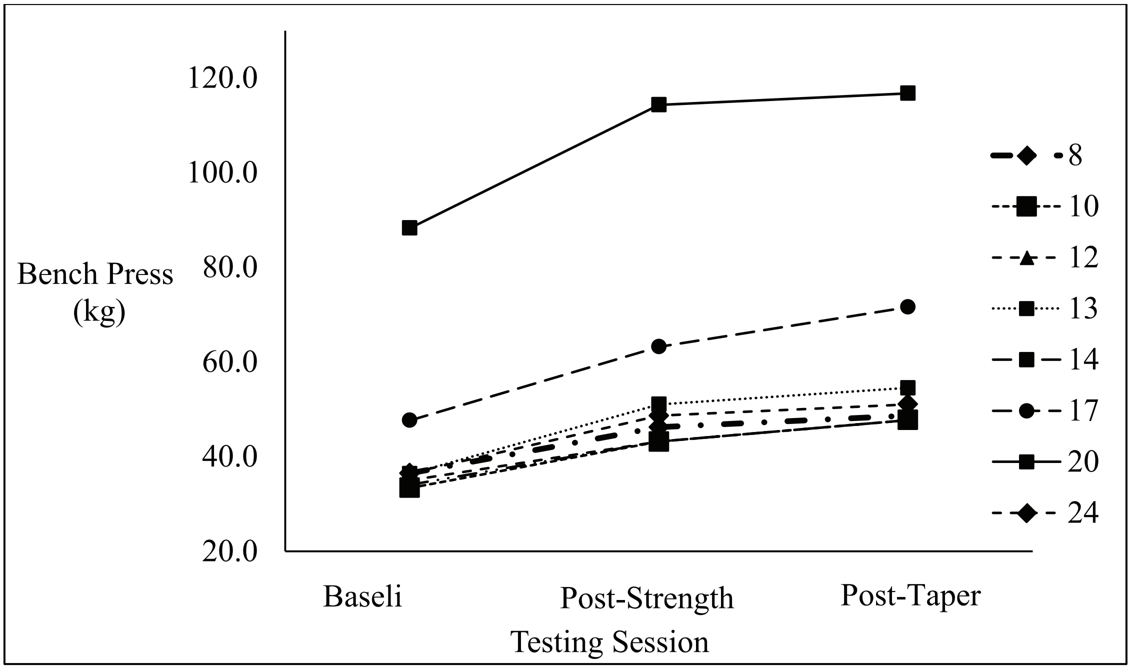

Figure 5 Displays the change in individual bench press strength for participants in the motor imagery group. All bench press weight is in kilograms (kg).

4.4 IMPACT OF MOTOR IMAGERY

The motor imagery groups' MIQ-R total scores improved from baseline (*M*= 2.8, *SD*= 0.5) to post taper phase (*M*= 1.45, *SD*= 0.6) *F*(1,8)=51.03, *p*=0.000. There was no change in MIQ-R scores from baseline (*M*=2.5, *SD*=1.0) to post taper phase (*M*=2.2, *SD*=0.5) *F*(1, 7)=0.009, *p*=0.860) for the placebo group. A significant difference was found between the motor imagery and placebo group MIQ-R total scores in both the post strength phase and post taper phase tests *p*=0.01 and *p*=0.00 respectively. Table 4 displays the MIQ-R visual, kinesthetic, and total scores for baseline, post strength and post taper testing.

Table 4 the MIQ-R Subscales and Total Scores for the Motor Imagery and Placebo Groups across the Three Testing Sessions

Test	Scale	Motor Imagery			Placebo		
		M	SD	*p* (within group)	M	SD	*p* (within group)
Baseline	*Visual*	2.5	1.1	-	2.3	1.3	-
	Kinesthetic	3.5	1.1	-	2.6	1.2	-
	Total	2.8	0.5	-	2.5	1.0	-
Post-Strength	*Visual*	1.5	0.7	-	2.3	0.9	-
	Kinesthetic	1.5	0.5	-	2.7	1.2	-
	Total	1.5	0.5	0.000[1]	2.5	1.0	0.540[1]
Post-Taper	*Visual*	1.4	0.6	-	2.2	0.9	-
	Kinesthetic	1.5	0.6	-	2.2	0.9	-
	Total	1.5	0.6	0.000[2], 0.310[3]	2.2	0.5	0.860[2], 0.400[3]

Note: p-value[1]= change from baseline to post-strength, *p*-value[2]= change from baseline to post-taper, *p*-value[3]= change from post-strength to post-taper

A regression analysis was done to examine the relationship between the post-taper MIQ-R scores and the pre to post-test change in upper and lower body strength measures. The regression was only done for the motor imagery group as the placebo condition did not receive any motor imagery training or show a change in mean MIQ-R scores. The post-taper MIQ-R score for each participant was found to be insignificantly correlated r=0.081, β=, -0.285, t(7)= 2.56, F(1, 8)=.531, p=0.494 to the change in respective overall back squat strength. This relationship is displayed in Figure 6.

The post taper MIQ-R score of each participant was found to be a significant predictor *r*=0.593, *β*=, -0.770, *t*(7)= 5.101, *F*(1, 8)=8.73, *p*=.025 of the respective change in overall bench press strength. This relationship is displayed in Figure 7.

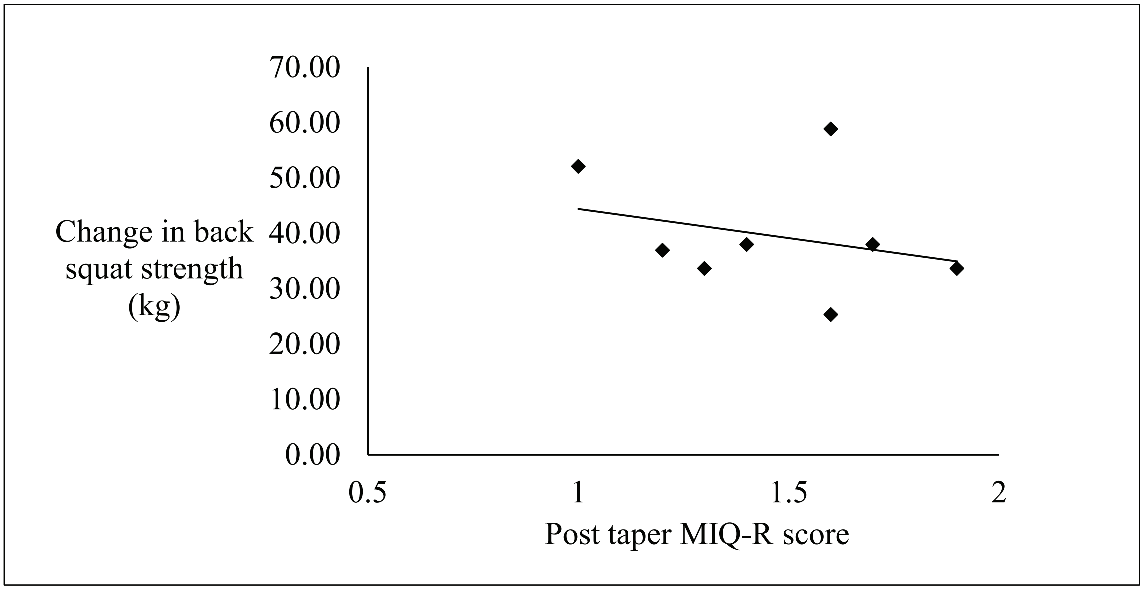

Figure 6 The overall change in back squat strength (*M*= 39.5 kg, SD= 10.8 kg) from baseline to post-taper for participants in the motor imagery group, compared to the respective participant's post-taper total MIQ-R score. This relationship was found to be insignificantly correlated *r*=0.081, *β*=, -0.285, *t*(7)= 2.56, *F*(1, 8)=.531, *p*=0.494 to the change in respective overall back squat strength

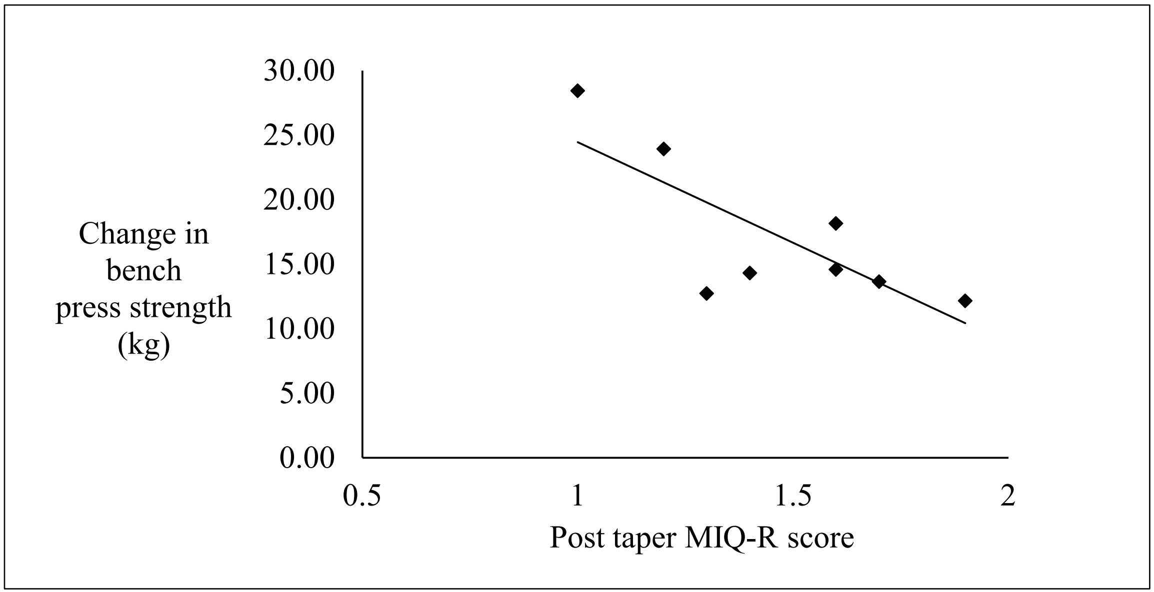

Figure 7 The overall change in bench press strength (*M*= 17.2 kg, SD= 5.9 kg) from baseline to post-taper for participants in the motor imagery group, compared to the respective participant's post-taper total MIQ-R score. This relationship was found to be a significant predictor *r*=0.593, *β*=, -0.770, *t*(7)= 5.101, *F*(1, 8)=8.73, *p*=.025 of the respective change in overall bench press strength.

Finally figures 8 through 13 represent the participant's individual back squat or bench press score in relation to their MIQ-R test score, for each of the baseline, post-strength and post-taper test sessions.

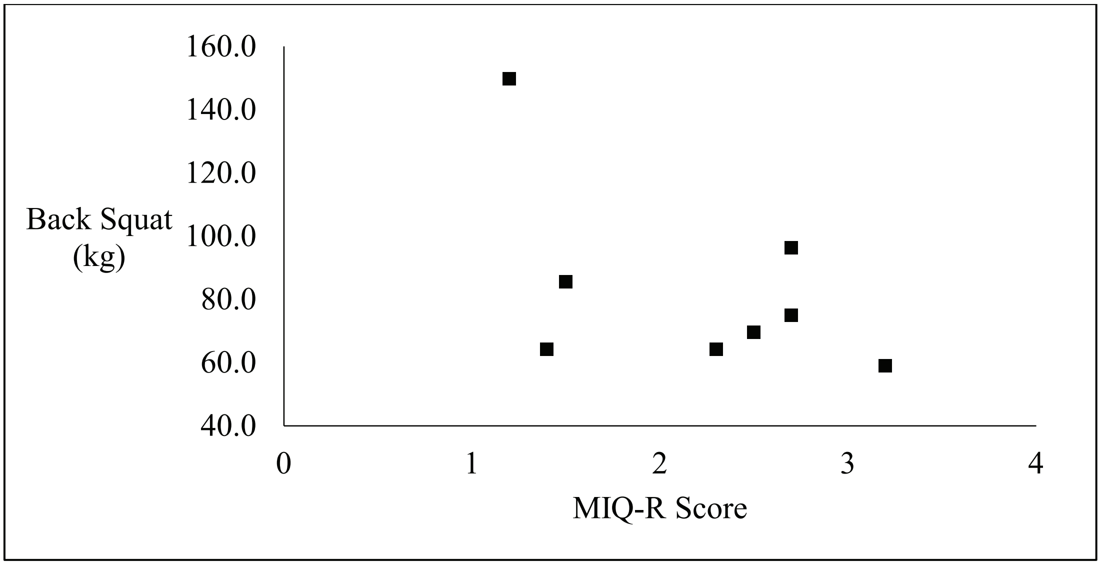

Figure 8 Represents the motor imagery group's individual back squat score in kilograms to their average total MIQ-R from the visual and kinesthetic subscales for the baseline test. The MIQ-R uses a 7-point Liekert scale, and a lower value represents a higher ability to image.

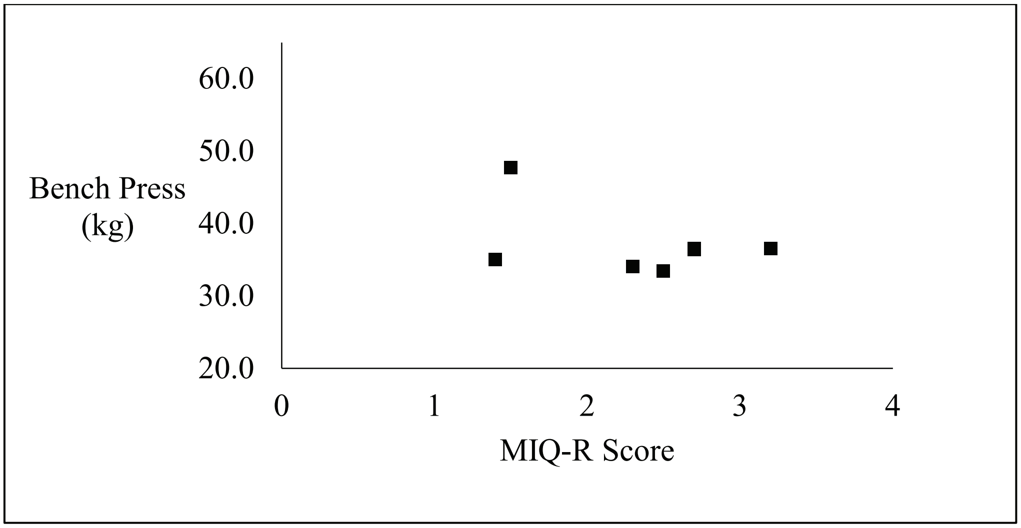

Figure 9 Represents the motor imagery group's individual bench press score in kilograms to their average total MIQ-R from the visual and kinesthetic subscales for the baseline test. The MIQ-R uses a 7-point Liekert scale, and a lower value represents a higher ability to image.

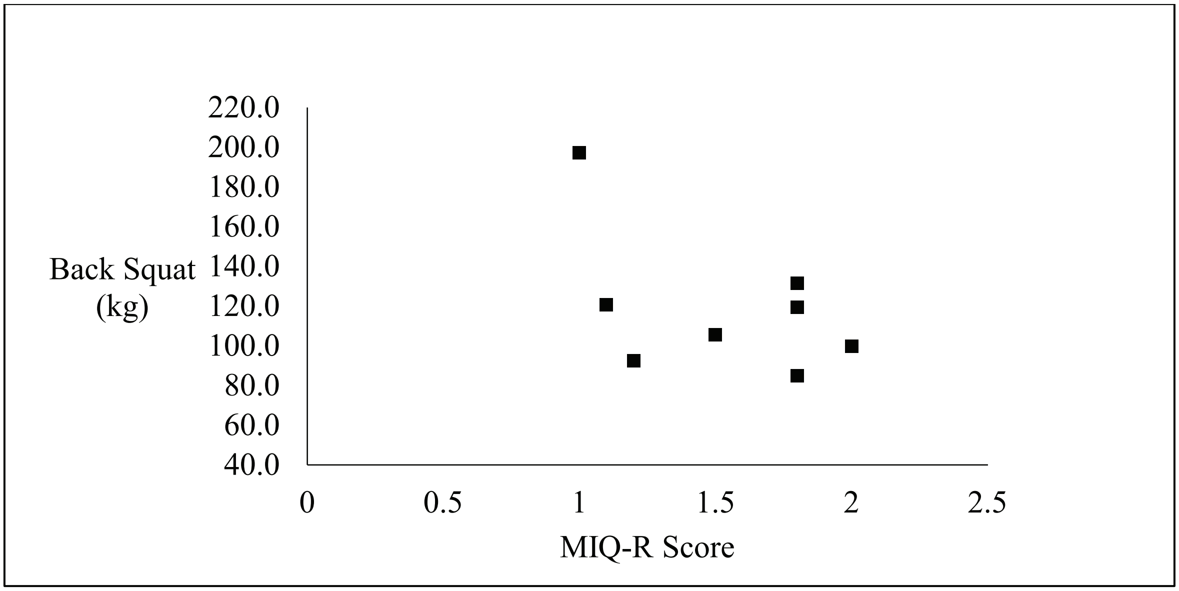

Figure 10 Represents the motor imagery group's individual back squat score in kilograms to their average total MIQ-R from the visual and kinesthetic subscales for the post-strength test. The MIQ-R uses a 7-point Liekert scale, and a lower value represents a higher ability to image.

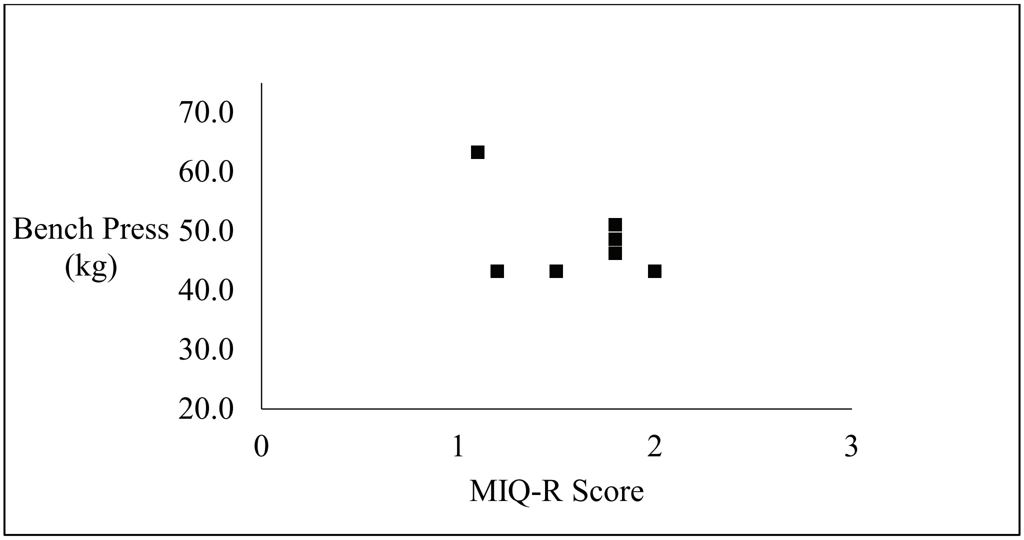

Figure 11 Represents the motor imagery group's individual bench press score in kilograms to their average total MIQ-R from the visual and kinesthetic subscales for the post-strength test. The MIQ-R uses a 7-point Liekert scale, and a lower value represents a higher ability to image.

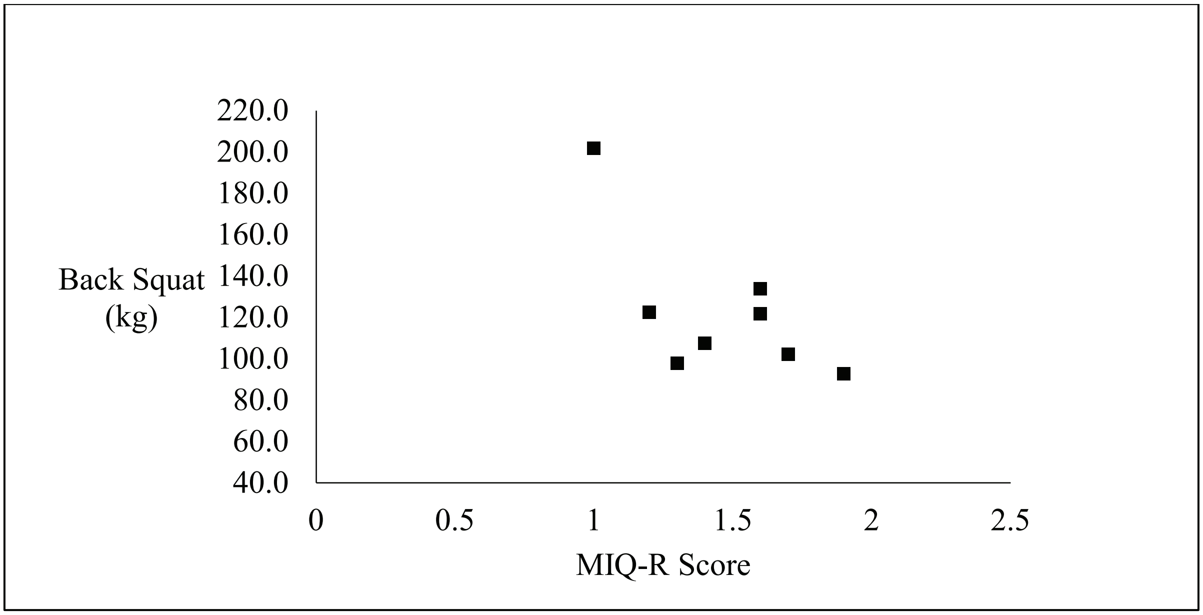

Figure 12 Represents the motor imagery group's individual back squat score in kilograms to their average total MIQ-R from the visual and kinesthetic subscales for the post-taper test. The MIQ-R uses a 7-point Liekert scale, and a lower value represents a higher ability to image.

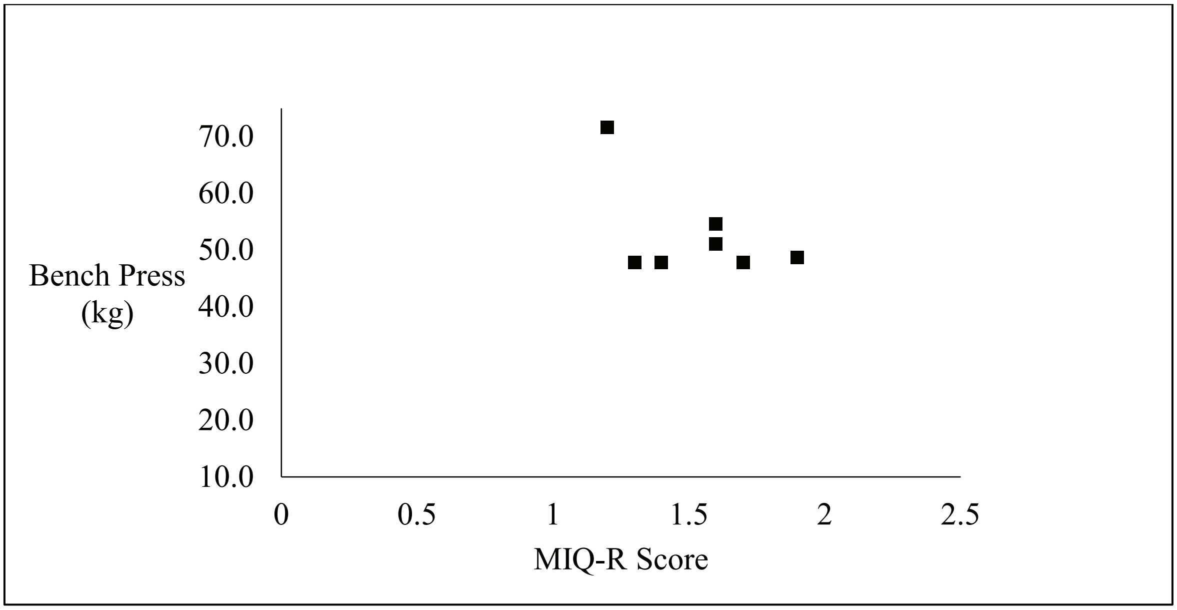

Figure 13 Represents the motor imagery group's individual bench press score in kilograms to their average total MIQ-R from the visual and kinesthetic subscales for the post-taper test. The MIQ-R uses a 7-point Liekert scale, and a lower value represents a higher ability to image.

4.5 EXIT INTERVIEWS

Tables 5 and 6 display the general categories present during the exit interviews for the motor imagery and placebo group respectively (refer to Appendix K for all supporting quotations). Five participants from the placebo group completed the exit interviews, and eight participants from the motor imagery group completed the exit interviews. Tables 5 and 6 below display each of the categories for the placebo and motor imagery groups respectively, found to meet the criteria outlined within the methodology. The number of meaningful units represents the total number of people whom completed each interview. Two categories were identified within the placebo group's exit interview, while five categories were identified within the motor imagery group's interviews.

Table 5 Placebo Exit Interview Categories

Category	Number of participants (Number of meaning units)	Quotation example
Listening to music was motivating	5 (5)	*Sometimes I found that listening to music focus and sometimes felt if really tired the music would focus/motivate you to do one more exercise rep* (Participant 18)
Listening to music had no impact on strength	4 (5)	*I feel the music didn't really matter. If I was improving I would have improved either way with or without the music. I feel the music didn't impact me one way or the other* (Participant 3)

Table 6   Motor Imagery Exit Interview Categories

Category	Number of participants (Number of meaning units)	Quotation example
Aiding in learning exercise technique	5 (8)	*Motor imagery improved technique, it would allow for more reflection on the exercises I was doing. When imaging correctly it helped improve technique, and was a continuous constant reminder of proper technique.* (Participant 20)
Timing of motor imagery	5 (8)	*I found when imaging after doing an exercise if I feel the exercise a lot (exertion) I would feel it more when imaging* (Participant 12)
High quality motor imagery impacts strength	3 (8)	*I think it (strength gains) for me came down to being able to image it (exercises) more vividly. But as I felt that there was more confidence in physical exercise there was more in motor imagery it was cyclical relationship* (Participant 24)
Motor imagery provides a stress to muscle	4 (8)	*I found that I even felt tired even when I didn't do as much (physical exercise) I felt tired and I was still stressing the muscles using motor imagery even though physical was down* (Participants 13)
Easy to incorporate motor imagery	3 (8)	*I found it easy, both for technique and once I got into the routine especially for big exercise and once I started feeling there were gains felt I didn't want to miss any motor imagery* (Participant 20)
Exercise experience impacted motor imagery ability	2 (8)	*I would say, I feel my experience with the exercise effected my ability to image* (Participant 24)

4.6 PERCIEVED EFFECTIVENESS THROUGHOUT INTERVENTION

The results for the perceived effectiveness of participant use of motor imagery are reported in table 7. This table displays the mean and standard deviation for use of motor imagery for the upper and lower body as well as how often they used it in relation to the required amount for each session. The mean and standard deviation are reported for each phase of the intervention. Table 8 displays the week by week perceived effectiveness for each measure.

Table 7 the Motor Imagery Group's Perceived Effectiveness Results For the Upper Body, Lower Body, and How Often Imagery Was Used Throughout the Intervention

Training Period	Overall		Upper body		Lower body		How often imagery was used	
	M	SD	M	SD	M	SD	M	SD
Familiarization	3.9	0.8	4.0	0.8	3.9	0.7	3.8	0.7
Strength training phase	4.4	0.6	4.4	0.2	4.3	0.3	4.5	0.3
Taper phase	4.8	0.4	4.8	0.2	4.8	0.4	4.9	0.2

Note: Scores are from a 5-point Liekert scale; 1= no image could be performed at all; 5= Vivid image could be performed

Within group significance was found for the perceived quality of participant's upper body imagery from familiarization training phase to post taper training phase $F(2, 8)= 5.588$, $p=0.047$, $\eta_p^2=0.444$ (large). An LSD post-hoc analysis revealed significance was found between the strength training phase and the taper training phase ($p=0.035$). Within group significance was found for the perceived quality of participant's lower body imagery from familiarization training phase to post taper training phase $F(2, 8)= 6.675$, $p=0.030$, $\eta_p^2=0.690$

(large). An LSD post-hoc analysis revealed significance was found between the strength training phase and the taper training phase (*p*=0.035). Within group significance was found for the how often the participants perceived to use motor imagery from familiarization training phase to post taper training phase $F(2, 8)= 9.678$, $p=0.013$, $\eta_p^2=0.763$ (large). An LSD post-hoc analysis revealed significance was found between the familiarization training phase and strength training phase (*p*=0.048), as well as the strength training phase and the taper training phase (*p*=0.003).

Table 8 the Weekly the Motor Imagery Group's Perceived Effectiveness Results For the Upper Body, Lower Body, and How Often Imagery Was Used

Week	Upper body		Lower body		How often imagery was used	
	M	SD	M	SD	M	SD
1	3.8	0.4	3.7	1.0	4.1	0.5
2	4.0	1.1	4.0	0.7	3.9	0.6
3	4.2	0.4	4.0	0.8	4.1	0.5
4	4.2	0.4	4.2	0.5	4.2	0.7
5	4.4	0.7	4.4	0.6	4.4	0.6
6	4.3	0.6	4.2	0.6	4.6	0.7
7	4.5	0.5	4.3	0.6	4.6	0.5
8	4.7	0.5	4.7	0.5	4.6	0.5
9	4.6	0.5	4.5	0.6	4.7	0.5
10	4.7	0.6	4.6	0.5	4.6	0.6
11	4.8	0.4	4.8	0.4	4.9	0.3

Note: Scores are from a 5-point Liekert scale; 1= no image could be performed at all; 5= Vivid image could be performed

CHAPTER 5 DISCUSSION

The purpose of this study was to determine the effects of motor imagery on the dynamic strength performance of the upper and lower body. The participants in this study engaged in an 11 week periodized strength training program. Baseline measures were repeated after 10 weeks of strength training and again after one week of decreased physical training (i.e., taper). The hypothesis that the motor imagery group would have a greater increase in strength performance was found to be not supported for the main effect for final outcomes of the back squat and bench press. However, support was found for a between group interaction effect for motor imagery having a greater impact on strength development compared to traditional strength training.

5.1 EFFECTS OF MOTOR IMAGERY ON STRENGTH

5.1.1 The Overall Effect of the Strength Training Intervention

The results from this study revealed that there was a significant main effect (p>0.05) for post training measures of the upper and lower body for both groups. This suggests that the 11 week strength training program was effective at increasing both upper and lower body strength. These findings were anticipated, as research has shown the use of a structured periodized strength training plan does result in strength gains (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Plisk & Stone, 2003). Additionally, it is reasonable to suggest that exercise selection or program design would not have limited any strength development within either of the two groups. This is important because previous research done in the field of motor imagery has not investigated the effect of motor imagery on dynamic strength during a structured periodized plan (Reiser et al., 2011). Based on the results of this study one can also conclude that motor imagery did not negatively impact the development of strength performance over the 11 week periodized study, as the imagery group did not have lower strength gains then the placebo group.

5.1.2 The Impact of Motor Imagery on Strength Outcomes

There was no significant difference or clinically meaningful effect between the motor imagery or placebo groups, for the final strength measures of either the upper or lower body. Therefore, it would appear that motor imagery had only a minor effect on final outcome measures. These results are similar to that of Reiser et al. (2011), who found no significant difference in the maximal isometric voluntary contraction for a leg and bench press. Similar to Reiser et al., this study had four weeks or more of base training before focusing on maximal strength efforts. This resulted in a total of nine and eleven weeks of strength training in each respective study. This was done to represent the practical application of motor imagery to a periodization strength program. This design is unlike other research that has found a significant effect on the impact of strength from using motor imagery (Ranganathan, 2004; Reiser, 2005; Smith et al., 2003; Yue & Cole 1992; Zijdewind et al., 2003). The studies which found a significant effect generally had a shorter overall training time (two to four weeks). The elongated training in this present study may have contributed to the small effect seen in overall strength gains from using motor imagery (Reiser et al.). These results are interesting as one would believe a larger amount of time practicing motor imagery would lead to larger strength gains. However, the increased proficiency in motor imagery may have been negated by the contribution of other strength attributes such as muscle hypertrophy (Reiser et al., 2011).

However, analysis of girth measurement results from this study revealed no significant difference for change in girth size from pre to post-test measurements. This would lead one to infer no muscular hypertrophy occurred as a result of the strength training in this study. These findings are not consistent with other research in muscular adaptation which suggests, after six to eight weeks of strength training hypertrophy of muscle fibers start to occur (Baechle & Earle, 2008; Fleck & Kramer, 2003; Folland & Williams, 2007).This results in an increase in muscle fiber size. A limitation of the current study was no direct measurement of muscle tissue (e.g., muscle biopsies), and the use of girths can make it difficult to detect muscular changes due to the influence of subcutaneous tissue (Cureton, Collins, Hill, & Mcelhannon,1988; Weiss, Coney, & Clark, 2000). Therefore it is difficult to conclude the true nature of morphological change as a result of this study.

Strength training programs utilize techniques (i.e., high intensity lifting) that focus on further neurological adaptations (i.e., rate coding and muscle synapses) and muscles density (i.e., increase/ realignment of myosin heads) (Fleck & Kramer, 2003; Haff, 2012; Holmes & Collins, 2002; Sale, 2003). These adaptations allow for greater increases in maximum strength. This type of focused training requires high intensity (i.e., heavy load) to stimulate central neural drive factors (Haff, 2012). Due to the necessity of high intensity, there is an increased risk of injury if proper form is not used (Baechle & Earle, 2008). However, these adaptations require long periods of focused training, above and beyond the 11 weeks of this study (Bompa & Haff, 2009; Fleck & Kramer, 2003; Sale, 2003). Additionally, due to the varied training experience of the sample in this study, it would have been inappropriate to engage in high intensity, maximal strength focused training, without establishing base level competencies (Baechle & Earle, 2008; Bompa & Haff, 2009; Busso, 2003; Plisk & Stone, 2003).

Therefore it may be reasonable to conclude the contribution of other strength training attributes and necessity to establish a base level of strength may have minimized motor imagery's impact on the main effect (Guillot et al., 2008; Reiser et al., 2011). Furthermore, motor imagery may have been more effectively used during training which utilizes only high neural central drive factors like power or maximum strength focused training (Reiser et al., 2011). In future, studies should not only consider athletic experience, but strength training experience as well. This would enable one to engage in only maximal strength training, that focus on adaptations to central drive factors, avoiding muscular hypertrophy based training.

5.1.3 Interaction between Motor Imagery and Time of Strength Development

Of interest, the current study did find a significant large effect between program type and time for upper body strength. While not significant, an interaction effect was also noted for lower body strength (η_p^2=0.897; large). These results suggest that motor imagery appears to have an effect on strength development over time for both the upper and lower body. These results and that of similar studies, indicate that motor imagery does have an effect on strength even though a significant between group main effects was not found (Lebon et al., 2010 Ranganathan, 2004; Reiser, 2005; Smith et al., 2003; Yue & Cole 1992; Zijdewind et al., 2003). These results also suggest motor imagery may be more important in developing strength over a short period of time. A study done by Reiser et al., examined the impact of an imaged muscle contraction on maximal voluntary contraction of a bench press over the span of four weeks. The motor imagery group was found to have an increase in relative strength of (5.7%). Strength measures were assessed after one, two and four weeks of training. The strongest imagery effect (η_p^2=0.58) occurred after the first week of training. The findings from Reiser et al., suggest motor imagery can have an impact on strength development in a relatively short amount of time.

This may lead one to infer that if an additional training stimulus is needed, in a relatively short period of time, motor imagery may provide an optimal stimulus for rapid strength development. However, the scope of this current study did not examine the effect size of motor imagery on strength performance week by week. Future studies should monitor these effects each week, in addition to documenting the training focus. This may be of particular importance to understanding the length of time motor imagery can be utilized, and the prevention of a redundant training stimulus. This would also provide a better understanding to the type of training focus (e.g., maximum strength or hypertrophy) that can maximize the potential benefits of motor imagery.

5.1.4 Implementation of Motor Imagery and Training Focus

As highlighted earlier the results of this study did not find a significant difference or clinically meaningful effect between the motor imagery and placebo groups final strength outcomes. However, it is believed that the previous training experience of the participants resulted in an inability to engage in solely high intensity training which may have effected . However, a study by Ranganathan et al. (2004) found a 13.5% increase in elbow flexion strength upon the conclusion of a 12 week motor imagery training program. The authors postulate, that a mental repetition of maximal muscle activation increases the central drive command which provides cortical output signals for muscle activation. This enables the active motor units to achieve a higher intensity (i.e., increased discharge rate) (Guillot et al., 2008; Lorey et al., 2011). These findings are supported by other research studies that suggest the use of motor imagery is beneficial when training is focused on enhancement of maximal concentric strength (Lebon et al., 2010; Reiser et al., 2011). Thus, motor imagery may increase the effectiveness of exercise that has a high neural drive such as maximum strength or power training.

When using motor imagery, practitioners and athletes should consider the desired training effect (e.g., maximum strength, hypertrophy). Likewise, if motor imagery can result in an increase in neural activation or central drive factors one could infer it may be optimally used during periods which focus on these desired training, outcomes. Further research is needed to examine the possible effects motor imagery may have on training programs which focus on maximum power or rate of force development (e.g., explosive bench pulls or plyometric training) and other types of training that require a large amount of neural activation. Additionally, assessing strength in smaller increments (i.e., a weekly monitoring protocol) would allow one to understand when the largest effects from motor imagery occurred (e.g., maximal strength, technique focus, etc.). This would potentially promote optimal training responses when using motor imagery.

5.2 THE PERCEIVED EFFECT OF MOTOR IMAGERY

5.2.1 The Perceived Effective of Imagery on Strength Development

A possible explanation for the interaction effect seen on the timing of strength development is a possible enhanced exercise technique within the motor imagery group. This group used motor imagery as a supplemental training stimulus, in addition to strength training. This would increase the total time focusing on a given exercise. For example, during the final weeks of the strength training phase, the motor imagery group would do 4 sets of 4 repetitions of physical back squats, in addition to 4 sets of 4 repetitions of imaged back squats. The extra time focused on motor imagery allowed the participants in this group to concentrate on the exercise they were executing (e.g., back squat). This increase in training density may have led to a higher level of technical execution for a given exercise. Additionally, the participants within the motor imagery group felt the intervention impacted their technique development. This may have led to a greater exercise proficiency and quality of lift. Similar findings were reported by Lebon et al. (2010) where they concluded that motor imagery enhances the performance of an exercise from improved training technique. Lebon et al. came to these conclusions through the use of post intervention exit interviews of the participants. Similarly, when the participants for this study were asked: Do you think motor imagery improved or hindered exercise technique? A number of participants suggested it aided in the learning and refining of exercise technique. Specifically, participant #20 stated, "*the motor imagery would allow for more reflection on the exercise I was doing, it was also a constant reminder of proper technique*"; participant #12 noted, "*I feel the motor imagery helped because I was able to practice the movement more without actually doing it or becoming physically tired*"; and participant 14 stated, "*I think it improved technique because you could focus on which muscles were supposed to be working during the exercise*"; and participant 13 noted, "*I found it improved, because after doing exercise and trying to visualize it helped my nervous system, remember and know how to feel what it should be experiencing*"; finally participant 24 stated, "*I found the MI helped because you could focus a lot more on the specific aspects of it (the exercise), if you just do it physically you could be just focused on getting through the pain or physical exertion, where if you do motor imagery you can focus on just squatting*". This feedback further supports the notion that motor imagery has an impact on the participants' perceived development of exercise technique. However, it is unclear whether these developments arose from an increase in motor programming and neuromuscular efficiencies. Further research may be warranted in order to understand what accounts for the perceived enhancement of technical execution. Additionally, biomechanical analysis may provide quantifiable data to promote a further understanding of where technical development occurs.

5.2.2 Technique Benefit and Exercise Experience

The exit interviews for this current study revealed that not all participants found motor imagery to have a perceived benefit for all exercises. In fact, feedback from one participant suggests that one may require a base level of exercise competence (e.g., self-efficacy) in the physical execution of a specific movement in order for motor imagery to be effective. For example, participant 8 stated, "*I found it difficult to use motor imagery for lower body movement. I was not as connected to the feeling as upper body maybe because it was a new exercise*"; participant 8 further stated, "*I found sometimes I would start off trying to feel the movement, but then I would start imaging improper technique*". Although this particular comment was not prevalent throughout the exit interviews, consideration to imaging ability and exercise experience may also be useful. No articles known to the PI were found that have investigated the relationship between training age or exercise experience and motor imagery ability. However, research done investigating the relationship between general activity or task efficacy and mental imagery suggest expert athletes have a higher imaging ability (Arvinen-Barrow et al., 2007; Neumann & Gray, 2013). Additionally, a more experienced athlete completes the imaged execution of a given movement without failure. Therefore, it is fair to infer that previous training history or exercise expertise may play a role in imaging ability, and in turn the potential results seen from motor imagery.

Research done investigating one's self-efficacy and imagery use in collegiate golfers, also revealed a higher level of self-efficacy resulted in more imagery use (Beauchamp, Bray, & Albinson, 2002). Additionally, lower levels of self-efficacy result in movement mistakes within the actual image (Bandura, 1997). Finally, Beauchamp et al., also reported those who used a greater amount of successful imagery achieved a higher level of in sport performance. These findings further suggest that one's perceived ability to image, not only impacts the amount of imagery used but, also the potential benefits from using imagery. Therefore, it may be of benefit to ensure a base level of strength training ability exists, in addition to a high level of athlete imaging and strength training efficacy.

5.2.3 Perceived Effectiveness of Motor Imagery Use throughout the Intervention

In addition to the categories discovered from the exit interviews, the motor imagery perceived effectiveness scores (refer to Table 7 and 8) of the lower body, upper body and how often imagery was used suggest the participants perceived motor imagery provided some benefit. There was significant ($p<0.05$) increase in participants' perceptions of effectiveness across all measures over the course of the intervention. These findings, further support the categories found in the exit interview, which suggest participants perceived a benefit when using imagery. Additionally these results were expected as Reiser et al., (2011), used a similar scale to assess overall imagery vividness, which revealed a range of rating from 3.0 to 4.3, suggesting all the participants perceived their own imagery to be of moderate to high quality. However, Reiser et al.'s results are slightly lower than the final perceived ratings in this study. One possible explanation of this is this study broke up the imagery assessment to upper and lower body, in addition to how often imagery was used, and did not use a general assessment of overall imagery for the session. Separating the body into upper and lower body may have increased the accuracy of the participant assessment for a specific area and not just a general assessment.

Finally, the perceived effectiveness scores also increased throughout the intervention. Interestingly, a significant increase in motor imagery ability was found over the duration of the intervention. This would suggest, as the participants ability increased so did the perceived impact of motor imagery on the upper and lower body, as well as how often imagery was used. The findings from this current study (refer to Table 6 and 7) further support the notion that expert imagers will have a higher self-efficacy when imaging, and in turn perceive to experience a greater benefit (Beauchamp et al., 2002).

5.3 PERIODIZED STRUCTURE AND SPORT RELEVANCE

5.3.1 Motor Imagery and Taper Effects

After a comparison of post strength to post taper measures, the back squat did not increase as expected. Although the motor imagery group did demonstrate a 3% increase from post strength to post taper scores, the placebo group had an increase of 7%. A possible explanation for the decreased rebound effect was that, two of the participants in the motor imagery group expressed feeling back discomfort during their post-taper testing session. This may have hindered their overall performance. When one is executing a back squat, there is a high level of core (abdominal, low back, erector spinae group etc.) activation, in addition to compressive forces on the spinal column (Baechle & Earle, 2008; Clark et al., 2012; McGill, 2006). The combination of these factors may have amplified any low back discomfort, resulting in a decreased performance. As a result, they had to stop increasing the load, even though they felt they could lift more.

The bench press on the other hand does not result in the same level of compressive force on the spinal column or require the amount of core activation seen in the back squat (Saeternakken & Fimland, 2012). As a result, it is difficult to conclude the effect of using motor imagery during a taper phase on back squat performance for this study. However, Reiser et al. (2011) conducted a study with a similar decrease in training volume following eight weeks of training. Reiser et al., found the motor imagery groups were able to maintain strength performance without the presence of any physical training in a second post-test one week after the first. This leads one to speculate that motor imagery could be used to replace physical training volume and a functional equivalence may exist between motor imagery and motor performance (Reiser et al., 2011).

Although the rebound effect was only minor in back squat scores (3%), there was an 8% increase in bench press performance for the motor imagery group. This resulted in a significant difference for the post-strength to post taper measure between the intervention and placebo groups. The intervention group had a mean change of 4.08 kg and SD of 1.99 kg, while the placebo group had a mean change of -0.51 kg and SD of 2.13kg. Furthermore, participant 17 within the motor imagery group displayed the largest change in bench press strength from post strength to post taper tests with an increase of 8.4 kg. Additionally, four other participants displayed increases of 3.5 kg or greater, while the largest increase for the placebo group was 2.5 kg (participant 3). These results would suggest that motor imagery was effective a providing an additional "rebound" stimulus to the upper body.

This could lead one to infer if the motor imagery participants were not experiencing back discomfort a larger rebound effect may have been present. Therefore, it is not possible at this time to conclude the effects motor imagery after a one week taper phase on lower body strength. However, even with the limitations found in two of the participants, motor imagery did not have a negative effect on strength as all motor imagery participants increased their back squat after a week taper. Additionally, motor imagery may be better utilized as a strength maintenance tool, as opposed to enhancing performance. More research is needed in understanding the length of time motor imagery could provide a stimulus to maintain strength in trained athletes, especially in those participants who are not expert imagers.

5.3.2 Motor Imagery and Fatigue during Taper

The magnitude of positive effect from motor imagery may have been limited by participant constraints (e.g., back discomfort). However, one can conclude the neuromuscular stimulation present when using motor imagery, during a taper, does not appear to contribute to any post-training fatigue. This is evident because significance was found for the between group bench press scores from post-strength to post taper phase (Table 3). Additionally, the back squat scores for the motor imagery group did not decrease in the post taper phase. Further research investigating an elongated taper phase with the use of motor imagery as a training stimulus may be of benefit. This would enable one to understand if motor imagery could maintain a training stimulus for longer than one week prior to competition. However, based on the findings of this study and Reiser et al. (2011), it is reasonable to infer that motor imagery may provide a sufficient stimulus to maintain strength for a short period of time (e.g., 1 week). Furthermore, when injured, motor imagery has been established to increase strength or negate strength loss (Hortobayi et al., 2000; Mulder et al., 2006; Newsom et al., 2003). Understanding this relationship could possibly allow for more physical rest prior to competition, and in turn enhanced performance.

5.3.3 Does a Small Effect Matter?

Although there was no significance between group intervention and post-test strength measures, the motor imagery group consistently demonstrated higher strength scores across all measures (refer to Table 3). A mean score of 7% higher on the back squat at the post strength test, and 3% higher at the post taper test was found for the motor imagery group. Likewise, the motor imagery group had a mean score of 2% higher on the bench press at the post strength test, and 10% higher at the post taper test. Again, while these differences were not statistically significant, a small effect was noted for both the upper (η_p^2=0.002) and the lower (η_p^2 = 0.004) body, although very small there may still be benefit in motor imagery from an applied perspective. For example, a sport such as 200m sprint kayak is highly focused on maximum power and central neural drive of muscle groups (Liow & Hopkins, 2003). The high power outputs and rapid velocity displayed in this sport results in a narrow gap between winning and losing. The difference between the first and fifth place finishers at the 2012 London Olympics was 0.579 seconds (1.6%) (The London Organizing Committee of the Olympic Games and Paralympic Games Limited, 2012). Therefore it may be reasonable to assume strength coaches and athletes may find benefit in using motor imagery even though a marginal difference on ultimate strength development may occur.

Interestingly, these relatively small strength increases and perceived benefits were expressed by multiple participants. For example, when the participants in this study were asked: Did you find the use of motor imagery aided/hindered in increasing your upper/lower body strength? A number of participants commented on the perceived usefulness or benefit they felt when using motor imagery. Specifically, participant 20 stated, "*I feel like I would use it if I was training for a sport competition of maximum strength focus. It could be very* *beneficial when training with a purpose*"; participant 20 further stated, "*I was unsure when I started lifting in the first couple weeks, but I saw bigger gains from this (motor imagery) in my strength when compared to gains in previous workouts outside of study, and once I started feeling there were gains I felt I didn't want to miss any of it (motor imagery)*". Participant 12 similarly noted, "*I wasn't very strong in my upper body when I was lifting, but at the end I don't think I could of lifted that much without using it (motor imagery) …as I said before I could feel it more and it made me want to push myself more*"; and finally participant 24 stated, "*As the study progressed you could see results. I am sure there would be results without imaging but I felt like it was more with it*". Other research has identified similar comments through the exit interviews where their participants reported that they felt motor imagery had a direct impact on strength (Lebon et al., 2010).

5.4 MOTOR IMAGERY QUALITY

While several questions remain with regards to the relationship between motor imagery and strength development, it does appear that those with higher imagery ability will benefit the most (Guillot et al., 2008; Lebon et al., 2010; Reiser et al., 2011). However, the current study found mixed results, with higher bench press scores reported for those with a higher MIQ-R (Figure 7), but not for back squat (Figure 6). However, these results may have been affected by the back discomfort two of the intervention participants experienced in this study. As these two participants had a relatively high MIQ-R score and low change in overall back squat strength from baseline to post taper tests (change in back squat strength = 33.6 kg and 36.9 kg) with a respective post taper MIQ-R score of (1.3 and 1.2) when compared to other participants. Therefore, it would be reasonable to assume if the participants would have been able to fully perform at the second post-test, MIQ-R score may have been positively correlated to a higher change in strength.

This relationship has also been established in another study that found that motor imagery had a moderate positive correlation with relative strength gains (Reiser et al., 2011). To examine this relationship Reiser et al. asked each participant to give a global evaluation of motor imagery at the end of each session. The participants rated their imagery on a scale 1 (no imagery could be performed) to 5 (vivid imagery could be performed). The results from this study revealed participants scores ranged from 3.0 and 4.3 (*M*= 3.6, *SD*=0.4).

Reiser et al. (2011), hypothesized this relationship may have been poorly represented do to the relatively small variance in motor imagery ability. Therefore, a median split was used to arrange participants into good and excellent imagers. This data split revealed excellent imagers had shown a greater improvement in overall strength (Reiser et al., 2011). Reiser's et al., study and this current study are the only known studies to quantify the relationship of motor imagery to strength performance gains. However, imagery vividness and quality of general motor skills have been positively correlated in other research (Munroe et al., 2000). This would lead one to infer that the true impact of motor imagery is dependent on one having a level of expertise in motor imagery itself. In turn enabling, one to maximize the potential benefits of using motor imagery. Therefore, ensuring a high quality of motor imagery is of utmost importance for the trainer or researcher.

Imagery vividness is reflected in the quality of a given movement within the working memory and is correlated with neural activation in motor related brain processes (Guillot et al., 2008; Reiser et al., 2011). Therefore, participant rating of imagery quality may reflect the quality of internal stimulation of working muscles for a given movement (Reiser et al., 2011). This concept was also revealed in the exit interviews when the participants were asked: Did you find the use of motor imagery aided/hindered in increasing your upper/lower body strength? A number of participants expressed the quality (vividness) of their motor imagery directly impacted strength gains and was an important factor. Specifically participant 24 noted, "*I think it (strength gains) for me came down to being able to image it (exercises) more vividly. But as I felt that there was more confidence in physical exercise there was more in motor imagery it was cyclical relationship*"; participant 8 also noted, "*I think doing visualization of the upper body I could feel the upper body (visual and kinesthetic)… this allowed me to feel I could do more physically*" and finally participant 12 noted, "*it was a cyclical relationship, the better I lifted, lead to higher quality imagery, which lead to more quality lifting. It kept on going*". The exit interviews further support the notion that imaging vividness was felt to impact strength development. Additionally, when one is imaging more vividly, one will have a higher quality physical lift as well (Reiser et al.). Ensuring high quality imagery, in addition to discovering the best way to teach imagery appears to be imperative. Further studies identifying specific athlete qualities which lead to high motor imagery quality would be beneficial.

5.4.1 Impact of Motor Imagery Training on Imaging Ability

This study found that the 11 week training intervention was found to be effective at increasing the participants imaging ability. To the PI's knowledge this is the only strength training focused study known to assess participant motor imaging ability using the MIQ-R at both pre and post-test measures. Lebon et al. (2010), did report that during the exit interviews participants felt their imaging ability improved as a result of the study and imagery script, however no quantitative findings were reported. The finding of this study quantitatively support the qualitative findings of Lebon et al.

Interestingly, the current study used only one imagery script for all participants in within the motor imagery group throughout the intervention, and still found a significant improvement in imaging ability. This is contrary to other research done in the field of motor imagery which suggests optimal results from an imagery intervention occur when the imagery is individualized (Wilson et al., 2010). However the motor imagery intervention utilized the Holmes and Collins (2002) PETTLEP model, which enables an individual to focus utilize a general imagery script and personalize different aspects of the movement (e.g., the weight being lifted; Wilson et al., 2010; Wright & Smith, 2009). Additionally, Lebon et al., (2010) found during the exit interviews that participants did not switch the script at all to make in more individualized. This would suggest along with the findings from this study and other research done, that the PETTLEP is effective at creating an individualized motor imagery program even if one script is used (Holmes & Collins, 2007; Reiser et al., 2005; Reiser et al., 2011; Wright & Smith, 2009).

However, the PETTLEP model, and other research done fails to periodize imagery training, similar to how one would periodize an athlete’s strength or technical training. Future research should examine the performance effects of periodized imagery training through the manipulation of the frequency, intensity, type and volume of imagery use. This would provide quantitative support to how much imagery should be done and when different types of imagery (e.g., motor imagery, arousal imagery) should be used throughout an athlete’s competitive cycle.

5.5 PRACTICAL IMPLICATIONS

The use of motor imagery may be most useful during periods which require rapid gains in strength over a limited time period. Additionally, motor imagery may prove to be beneficial during training that is focused on high neural activation (e.g., maximum power). It also appears that motor imagery may have some benefit in aiding in the learning of exercise technique. However a level of exercise competence appears to be required for maximal benefit. Therefore, motor imagery may be best used when refining an athletes' technique.

Ensuring motor imagery quality is paramount to maximizing the possible benefits one can achieve. The use of guided or monitored imagery, appear to be methods which aid in maintaining quality. Additionally, assessing perceived image quality after use would be of benefit. This could happen through periodical testing sessions using the MIQ-R or using self-reported post training session assessment. Importantly, self-reports from the participants in this study revealed using motor imagery during rest periods was not a hindrance on overall exercise experience. This is consistent with results found in other research (Lebon et al., 2010; Reiser et al., 2011). Therefore, having athletes use motor imagery during rest periods would not negatively affect training, and could prove to be beneficial.

Overall, high intensity physical training is required to achieve gains in maximum strength (Baechle & Earle, 2008; Bompa & Haff, 2009; Reiser et al., 2011). While motor imagery is not intended to replace physical training, it may prove to be beneficial in maximizing gains during focused training periods. In addition it can provide a maintenance stimulus to strength during periods of reduced physical training.

5.6 LIMITATIONS

There were a number of limitations which existed in this study design. There was the possibility of treatment diffusion from the motor imagery group to the motivational music group. However, this was addressed by separating the strength training times of each group. Therefore the entire intervention group trained together and the entire placebo trained together at a separate time of day. Additionally, the participants within each group had no relationship with any participants in the other group. One other possible way the diffusion of motor imagery may have occurred, was the placebo group could have unknowingly used self-implemented motor imagery. However, motor imagery was not mentioned or discussed to the placebo group. Additionally, the word motor imagery was not used on any of the consent forms used for this study. During the intervention the placebo group listened to motivational music, this was hoped to provide a distraction and reduce the potential risk of this occurring. The participants were also blinded to the true title of the study. This was ethically approved as a reasonable step to take. As the original title had the words 'motor imagery' in it, and the participants from the placebo group may have questioned what it was or why they were not experiencing this intervention.

Another limitation of this study was the PI supervised the training intervention for both groups. This could have led to an inadvertent research bias. However, due to the potential risk of injury from participating in complex exercises, the PI had to diligently supervise both training groups. Furthermore, the quality of training programs was monitored by both the PI's supervisors and RA's. Likewise, all fitness testing was conducted by a CSCS certified RA blinded to the participant group allocation. Finally, the PI is invested in the field of research for exercise physiology and psychology in addition to maximizing any potential applied benefits to these fields. As such the PI was focused on ensuring the integrity and quality of his work was at the highest level.

Another limitation was the risk of extraneous factors influencing testing results. While steps were taken to eliminate extraneous factors that may have influence training outcomes (e.g., rest or hydration status), participant behaviours are outside of the PI's control. However, pre-testing guidelines were established in an effort to mitigate these factors (refer to Procedures). This included: hydration status recommendations, conducted testing at the same time of day, used the same testing supervisor, and the sequencing of tests were the same for each session. Emails were sent two weeks in advance informing participants about an upcoming testing session in addition to reminders at the training sessions.

The most substantial limitation of the present study was the small sample size. While several strategies were used to improve recruitment, the resultant sample was smaller than originally anticipated resulting in reduced statistical power. Given the difficulty in the retention of participants, exit interviews were used to supplement the quantitative findings of this study.

The motor imagery intervention itself was a final limitation of this study. This limitation existed from ensuring the participants' ability to effectively utilize motor imagery, as well as the imagery script itself. This was a concern because an unskilled participant could skew or negatively affect the potential gains in strength performance within the motor imagery group. In order to account for this, all eligible participants must have achieved a minimum score of 3.0 on the MIQ-R (Hall & Martin, 1997; Reiser et al., 2011). Additionally, motor imagery training sessions were dispersed throughout the intervention.

This ensured the participants were comfortable using motor imagery and provided an opportunity for the participant to ask any questions and continually refine their skills. Motor imagery was also monitored each session through self-reported scores of motor imagery effectiveness and use.

The motor imagery script was a single script used throughout the intervention, as a result the motor imagery training itself failed to be periodized in a way similar to the strength training. This may have played a role in limiting any potential benefit in those who were excellent imagers from the start or early on in the intervention. Additionally, those whom are novice imagers may have been unable to fully utilize the motor imagery throughout the intervention because the script was too challenging. However, educational sessions were utilized throughout the intervention. These were hoped to provide additional opportunities for the PI to make any adjustment in a participants imaging ability, and provide opportunity for participants to ask any questions. Finally, all participants improved in their imaging ability, and there was found to be a significant improvement in participant perceived effect of imagery across all measures throughout the intervention. These findings would suggest that the script did not have a negative impact, but may have played a role in limiting any potential strength gains from using motor imagery, as between group significance was not found for the overall impact of imagery on strength measures.

5.7 CONCLUSION

This study contributes to the growing body of knowledge of motor imagery and athletic performance. Motor imagery does appear to play a role in the perceived technical development of an individual’s strength training exercises. This theme was clearly established throughout the exit interviews and other research done (Lebon et al., 2010).

However, a base level of physical competence may be required in order for an athlete to receive full benefit. Therefore, using motor imagery in athletes with some strength training experience would be beneficial.

A clear relationship was present between imagery quality and the degree of strength gains. This reinforces the notion that motor imagery quality is paramount. Therefore future studies are needed to examine the best possible practices for utilizing motor imagery. Additionally, this study suggests that motor imagery does have an impact on strength development.

The use of motor imagery during a period of decreased physical training does not negatively affect the “rebound effect”. This leads one to believe that motor imagery may be able to provide a stimulus to the muscle to maintain strength without the presence of physical training. Further investigation into the effects of elongated periods of decreased physical training and the effect motor imagery can have on maintaining strength are needed. This could lead to greater physical rest for an athlete and optimal performance in competition.

Finally, motor imagery is well established in being able to stimulate the neural pathways of a muscle (Guillot et al., 2008; Lebon et al., 2010; Ranganathan, 2004; Reiser et al., 2011; Reiser, 2005; Smith et al., 2003; Yue & Cole 1992; Zijdewind et al., 2003). However, understanding the optimal length of implementation and training focus (e.g., maximum power) for motor imagery use, may be warranted in order to maximize the potential performance benefits. This understanding will allow one to maximize the effects of using motor imagery for optimal performance gains. This is of practical importance since the potential difference between winning and losing is minute, especially in sports focusing on maximum strength or high neural drive.

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APPENDIX A

LETTER OF PERMISSION CSCA

Canadian Sport Centre
Centre canadien multisport
Atlantic/Atlantique
Committed to supporting high performance athletes in Atlantic Canada

To whom it may concern,

I herby grant Jesse Adams access to the Canadian Sport Center Atlantic Training and testing facilities, to conduct research for his study: THE EFFECTS OF MOTOR IMAGERY ON STRENGTH PERFORMANCE.

Sincerely,

Ken Bagnell, President of Canadian Sport Center Atlantic

APPENDIX B

RECRUITMENT POSTER

Canadian Sport Centre
Centre canadien multisport
Atlantic/Atlantique

DALHOUSIE UNIVERSITY
Inspiring Minds

Are you an elite athlete who wants to take their strength training to the next level?

If so, we would like to hear from you.

We invite you to participate in a research study exploring the use of motor imagery as a part of a strength program, in order to maximize the potential neurological adaptations from training. You must be between the ages of 15 and 24, and have played a sport above a recreational level.

Each participate will be required to participate in 4 testing sessions lasting approximately 1.5 hours each, In addition to approximately 3 hours of training per week over 10 weeks.

Note: *You may discontinue the study at any time and your information will be removed from the study*

If you are interested and want more information please contact:

The Effect of Motor Imagery on Strength Performance. If interested please contact Jesse Adams @ 902-452-7683 or at jesseadams@dal.ca

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RECRUITMENT LETTER/ EMAIL

Dear coach/athlete,

My name is Jesse Adams, I am a Masters student at Dalhousie University within the Faculty of Health and Human Performance. I am going to be conducting a research study about the effects of arousal techniques on strength performance. The study will engage participants in a 13 week strength training program in addition to the arousal techniques. During the study participants will undergo 4 different testing sessions, which will examine maximum strength of the upper and lower body. All participants will get the benefit of a structured strength program implemented by a certified NSCA strength coach with Masters level education. In addition, access to the Canadian Sport Center Atlantic (CSCA) training facilities will be available for participants to use during the 13 weeks study. If you are interested in participating or would like more information on this study please contact Jesse Adams at jesse.adams@dal.ca or 902-452-7683.

Thank you for your time and your participation is greatly appreciated,

Jesse Adams,

MSc (c), Dalhousie University, School of Human Health and Performance

APPENDIX C

MOTOR IMAGERY GROUP CONSENT FORM (YOU)

School of Human Health
And Performance

INFORMED CONSENT FORM
The effects of mental focusing and motivational techniques on strength performance

Supervisors:

Dr. Carolyn Savoy	**Dr. Melanie Keats**
Department of Kinesiology **School of Human Health and Performance** **E-mail: carolyn.savoy@dal.ca**	**Department of Kinesiology** **School of Human Health and Performance** **Phone: (902) 494-7173** **E-mail:melanie.keats@dal.ca**

PRINCIPAL INVESTIGATOR:

Jesse Adams (MSc Candidate)
Principal Investigator

Department of Kinesiology
School of Human Health and Performance
Dalhousie University
6230 South Street
Halifax, NS. B3H 4R2

(902) 452-7683
Jesse.adams@dal.ca

INTRODUCTION

We invite you to take part in a research study being done by Jesse Adams, within the School of Human Health and Performance, Department of Kinesiology at Dalhousie University. Your participation in this study is entirely voluntary and you may leave the study at any time. The study is described below and tells you about the potential risks, inconvenience, or discomfort which you may experience. Participating in this study might not benefit you directly, but we might learn things that will benefit others. Should you have any questions about this study please contact the Principal Investigator, Jesse Adams.

PURPOSE OF THE STUDY

The purpose of the proposed study is to understand the effect of two different forms of mental focusing combined with strength training on strength performance.

STUDY DESIGN

You have been randomly selected (e.g., similar to flipping a coin) to participate in a 13-week strength training program that includes motor imagery training. Through the course of the study you will participate in testing sessions during weeks 1, 3, 10, 13. After each of the strength training sessions you will fill out a pen and paper questionnaire that will take 1 to 2 minutes.

TIME COMMITMENT				
Task	Time/ session (hrs)	Number of sessions	Number of weeks	Total number of sessions
Testing	1.5	4	Familiarization test: Week 1 Baseline test: Week 3 Pre-training decrease test: Week 10 Post intervention test: Week 13	4
Strength training	1-1.5	3	8	24
Reduced strength training	1-1.5	2	2	4
Total commitment	**55hrs**		**13**	**38 sessions**

WHO CAN PARTICIPATE IN THIS STUDY

You are able to participate in this study if you are a male or female, live in Nova Scotia, and have participated in competitive sport within the last two years. For the purpose of this study a competitive athlete is someone who participated in a sport where the primary goal is winning and practice to increase their skills/performance. You must be between the ages of 15 to 24. If you are 17 years of age or younger you require a parents signature.

WHO WILL BE CONDUCTING THE RESEARCH

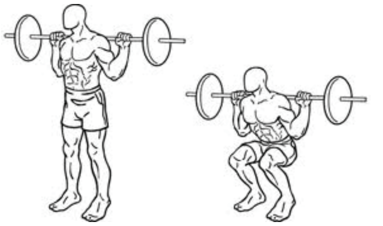
Jesse Adams the Principal Investigator for this study and will oversee the testing and strength sessions. The Research assistants (Director of sport science CSCA Leo Thornley MSc, CSCS; CSCA lead strength coach Darren Steeves, CSCS, MSc; CSCA strength and physiology consultant Scott Willgress, CSCS, M Kin) are Certified Strength and Conditioning Specialist (CSCS) and currently work at the Canadian Sport Center Atlantic. The CSCA works with elite athletes ranging from 14 years of age (developmental athletes) to 35 years of age (Olympic athletes). The CSCA is responsible for the design of the athletes exercise programs. The research assistants will be involved in the implementation of testing or strength training sessions. Supervisors Dr. Savoy and Dr. Keats, will provide guidance to the Principal Investigator throughout the study.

WHAT WILL YOU BE ASKED TO DO

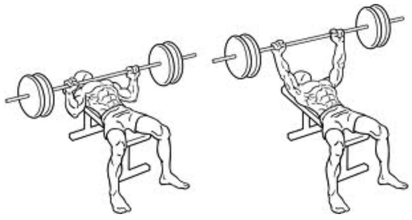
If you choose to participate, you will be asked to take part in a 13 week strength training program from June 2012 to September 2012. During the 13 weeks you will complete four testing sessions, strength training and motor imagery sessions. During the motor imagery sessions you will be instructed/ asked to imagine muscle contractions without any physical movement. During all strength and testing sessions you will be asked to wear athletic clothing (shorts and a t-shirt) in order to properly perform all movements.

The fitness test includes body measurements like height, weight, body fat and size (e.g. width of the upper arm). Strength testing includes a one repetition maximum bench press and a three repetition maximum back squat (refer to the diagrams below for an example of both the bench press and back squat). Both tests will be done under the supervision of the Principal Investigator or Research Assistants. The supervisors will ensure proper supervision in order to aid in preventing any injury from occurring. During the body measurement portion of the testing, upon your request you will have access to a private room.

Back Squat



Bench Press



During the strength training sessions a variety of strength exercises will be used which will focus on both upper and lower body. An example of an upper body exercise is a dumbbell bench press. An example of a lower body exercise is the back squat. A National Strength and Conditioning (NSCA) certified strength and conditioning specialist (CSCS) will be present at all time during both the testing and training sessions. The NSCA is one of the most reputable governing bodies for strength and conditioning research. This will ensure maximum safety and proper technique is used to achieve optimal benefits from each strength exercise.

At the end of every strength session you will be asked to rate the perceived effectiveness of your motor imagery technique. These questions will take a total of 1 minute at the end of the strength training session. Additionally, your answers will be written on a piece of paper and placed in a locked box. The only thing that can identify you on the paper is your subject number, and the only people looking at the paper will be the Principal Investigator or Research Assistants. In addition to the strength training program you will also receive several motor imagery technique training sessions. A total of 14 sessions will occur throughout the duration of the study ranging from 10 to 20 minutes.

POSSIBLE RISKS

It is possible that you may become stressed (e.g., physically, emotionally or psychologically) as a result of participating in this study. You will be doing strenuous strength training and this can result in injury (e.g., muscle strain, overuse injury, etc.). A NSCA certified strength coach will be present at all times to ensure proper technique and spotting. However, this does not guarantee that an injury will not occur.

If injury were to occur, all study staff are trained in Standard First Aid and CPR. Additionally, there are certified lifeguards in the Canada Games facility, and will be contacted if additional help is needed. Finally, if injury is severe 911 will be notified. If injured during the study a medical note must be presented to the Principal Investigator before continuing participation in the study. If medical approval is not given your participation in the study will be terminated and your all data will be removed.

Psychological or emotional distress (e.g., burnout) can also result from participating in physically strenuous exercises or thinking activities like strength training and motor imagery techniques. However, these sessions will be monitored by the Principal Investigator and Research Assistants to decrease any potential risk of distress.

All sessions have been developed in accordance to academically accepted strength training models and/or visualization models. The strength training will have a gradual progression from low strenuous exercise to more strenuous training sessions. An example of this would be at the start of the intervention you will use a strength training intensity of 50% of your one repetition maximum. Once you have adapted to this training intensity, it will be increased to 80% of your one repetition maximum. This will ensure that you do not over stress yourself and increase your risk of injury.

POSSIBLE BENEFITS

You will receive a 13 week training program designed by an NSCA certified strength coach which will take into account all aspects of designing a program for an elite athlete. While you may not directly benefit from participation in the study, your participation will help us to better understand how to improve sport performance in elite and recreational athletes.

EXCLUSION/WITHDRAWAL FROM THE STUDY

For the 13 week duration of this study, you will not be permitted to participate in a strength training program outside of this study. Finally, if you are absent for 3 consecutive strength sessions or a total of 6 sessions over the 13 week study, you will no longer qualify for this study. At this time you will be thanked for your participation and all information collected from you will be destroyed.

If you feel uncomfortable about any of the testing or strength training sessions you may leave the study at any time. If you choose to leave the study all information connected to you will be removed from the study and destroyed. Your participation in this study is completely voluntary and should you decide not to participate in any portion of the study your data will be removed, and you may do so without question or consequence. If you complete the study, you will no longer be able to remove your data from the study.

CONFIDENTIALITY & ANONYMITY

As you will be exercising in a group full anonymity in this study is not possible. However, all measures will be taken to ensure that you will not be identifiable to others as a participant in this study. The data which will be collected is of a personal nature, since will be examining a variety of body weight, height, fat percent, strength and psychological measurements. If you wish to have the body measurements done away from the group a private room is available, and only the Principal Investigator and/or research assistants will be present. Moreover, your test results will be kept strictly confidential and in no way will it be possible to link the results to you. Your name will not be used on any testing sheets or reports.

The Principal Investigator will be using a personal communication device (e.g., cell phone). However no other person other than the Principal Investigator has access or will answer this phone, as it is password protected. Additionally, no participant identifiable information will be stored on the device. Any information that is left on the phone will be destroyed upon the conclusion of the study.

The data collected will be stored on a password protected USB or hard drive and in a secure location that only the Principal Investigator or supervisors have access to. This consent form, and any other forms that contain personal information such as your name, will be stored in a locked filing cabinet, in a secure office within the Department of Kinesiology at Dalhousie University. It will be in a geographically separate location from all other data and never be used to identify participants. You will be assigned a number which is only used to organize your testing results for data analysis and in no way provide as a means to link the results to you. All data will be kept for seven years after completion of the study, as per Dalhousie

University ethics requirements. After the seven years all data will be destroyed and disposed of in accordance to Dalhousie University regulations.

If you disclose that you are/have been abused or neglected as a child (or vulnerable adult), you will be informed that the researchers are required by law to report this information to the authorities. Following the testing or training session the researcher will make a report with the appropriate authorities and inform the supervisor of their actions.

QUESTIONS

If there are any changes to this study, you will be given this information as it might affect your decision to participate. If you have any questions throughout the duration of the testing or strength sessions about this study or your participation, please do not hesitate to ask the researcher. Should you have any questions following a session you may contact the principal investigator at (902) 452- 7683 or via e-mail at jesse.adams@dal.ca. Please note that if you live outside the Halifax Regional Municipality you may contact the Principal Investigator via e-mail.

PROBLEMS OR CONCERNS

If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Catherine Connors at the Dalhousie Research Services Office at (902) 494-3423, ethics@dal.ca. Collect calls are always accepted.

SIGNATURE PAGE

The effects of mental focusing and motivational techniques on strength performance

I have read the explanation of this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent I will take part in this study. However I realize that my participation is voluntary and I am free to withdraw from the study at any time. I consent to my test results being recorded and stored on an encrypted password protected USB. Finally, I have received a copy of the consent form for my own records.

Participant Name:____________________________

Legal Guardian Name:________________________.

Legal Guardian/Participant Signature:____________________ Date:_________________

Principal Investigator Name:______________________________

Principal Investigator Signature:_________________________ Date:_________________

☐ I would like to receive a copy of my results in this study.

Please provide a complete mailing address in the space provided below if you would like to receive a copy of the study results.

INFORMED CONSENT FORM MOTOR IMAGERY GROUP (PARENT)

School of Human Health
and Performance

INFORMED CONSENT FORM
The effects of mental focusing and motivational techniques on strength performance

Supervisors:

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Jesse.adams@dal.ca

INTRODUCTION

We invite your son/daughter to take part in a research study being done by Jesse Adams, within the School of Human Health and Performance, Department of Kinesiology at Dalhousie University. Their participation in this study is entirely voluntary and they may leave the study at any time. The study is described below and tells you about the potential risks, inconvenience, or discomfort which your son/daughter may experience. Participating in this study might not benefit them directly, but we might learn things that will benefit others. Should you have any questions about this study please contact the Principal Investigator, Jesse Adams.

PURPOSE OF THE STUDY

The purpose of the proposed study is to understand the effect of two different forms of mental focusing combined with strength training on strength performance.

STUDY DESIGN

Your son/daughter have been randomly selected (e.g., similar to flipping a coin) to participate in a 13-week strength training program that includes motor imagery training. Through the course of the study they will participate in testing sessions during weeks 1, 3, 10, 13. After each of the strength training sessions they will fill out a pen and paper questionnaire that will take 1 to 2 minutes.

TIME COMMITMENT				
Task	Time/ session (hrs)	Number of sessions	Number of weeks	Total number of sessions
Testing	1.5	4	Familiarization test: Week 1 Baseline test: Week 3 Pre-training decrease test: Week 10 Post intervention test: Week 13	4
Strength training	1-1.5	3	8	24
Reduced strength training	1-1.5	2	2	4
Total commitment	**55hrs**		**13**	**32 sessions**

WHO CAN PARTICIPATE IN THIS STUDY

Your son/daughter are able to participate in this study if they are a male or female, live in Nova Scotia, and have participated in competitive sport within the last two years. For the purpose of this study a competitive athlete is someone who participated in a sport where the primary goal is winning and practice to increase their skills/performance. Your son/daughter must be between the ages of 15 to 24. If they are 17 years of age or younger they require a parents signature.

WHO WILL BE CONDUCTING THE RESEARCH

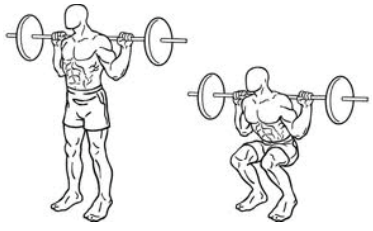
Jesse Adams the Principal Investigator for this study and will oversee the testing and strength sessions. The Research assistants (Director of sport science CSCA Leo Thornley MSc, CSCS; CSCA lead strength coach Darren Steeves, CSCS, MSc; CSCA strength and physiology consultant Scott Willgress, CSCS, MKin) are Certified Strength and Conditioning Specialist (CSCS) and currently work at the Canadian Sport Center Atlantic. The CSCA works with elite athletes ranging from 14 years of age (developmental athletes) to 35 years of age (Olympic athletes). The CSCA is responsible for the design of the athletes exercise programs. The research assistants will be involved in the implementation of testing or strength training sessions. Supervisors Dr. Savoy and Dr. Keats, will provide guidance to the Principal Investigator throughout the study.

WHAT YOUR SON/DAUGHTER WILL BE ASKED TO DO

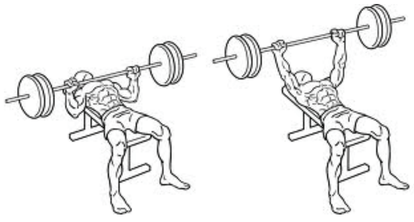
If your son/daughter chooses to participate they will be asked to take part in a 13 week strength training program from September 2012 to December 2012. During the 13 weeks they will complete four testing sessions, strength training and motor imagery sessions. During the motor imagery sessions they will be instructed/ asked to imagine muscle contractions without any physical movement. During all strength and testing sessions your son/daughter will be asked to wear athletic clothing (shorts and a t-shirt) in order to properly perform all movements.

The fitness test includes body measurements like height, weight, body fat and size (e.g. width of the upper arm). Strength testing includes a one repetition maximum bench press and a three repetition maximum back squat (refer to the diagrams below for an example of both the bench press and back squat). Both tests will be done under the supervision of the Principal Investigator or Research Assistants. The supervisors will ensure proper supervision in order to aid in preventing any injury from occurring. During the body measurement portion of the testing, upon yours or your son/daughter's request they will have access to a private room.

Back Squat



Bench Press



During the strength training sessions a variety of strength exercises will be used which will focus on both upper and lower body. An example of an upper body exercise is a dumbbell bench press. An example of a lower body exercise is the back squat. A National Strength and Conditioning (NSCA) certified strength and conditioning specialist (CSCS) will be present at all time during both the testing and training sessions. The NSCA is one of the most reputable governing bodies for strength and conditioning research. This will ensure maximum safety and proper technique is used to achieve optimal benefits from each strength exercise.

At the end of every strength session your son/daughter will be asked to rate the perceived effectiveness of their motor imagery technique. These questions will take a total of 1 minute at the end of the strength training session. Additionally, their answers will be written on a piece of paper and placed in a locked box. The only thing that can identify your son/daughter on the paper is their subject number, and the only people looking at the paper will be the Principal Investigator or Research Assistants. In addition to the strength training program they will also receive several motor imagery technique training sessions. A total of 14 sessions will occur throughout the duration of the study ranging from 10 to 20 minutes.

POSSIBLE RISKS

It is possible that your son/daughter may become stressed (e.g., physically, emotionally or psychologically) as a result of participating in this study. They will be doing strenuous strength training and this can result in injury (e.g., muscle strain, overuse injury, etc.). A NSCA certified strength coach will be present at all times to ensure proper technique and spotting. However, this does not guarantee that an injury will not occur.

If injury were to occur, all study staff are trained in Standard First Aid and CPR. Additionally, there are certified lifeguards in the Canada Games facility, and will be contacted if additional help is needed. Finally, if injury is severe 911 will be notified. If injured during the study a medical note must be presented to the Principal Investigator before continuing participation in the study. If medical approval is not given your son/daughters' participation in the study will be terminated and their all data will be removed.

Psychological or emotional distress (e.g., burnout) can also result from participating in physically strenuous exercises or thinking activities like strength training and motor imagery techniques. However, these sessions will be monitored by the Principal Investigator and Research Assistants to decrease any potential risk of distress.

All sessions have been developed in accordance to academically accepted strength training models and/or visualization models. The strength training will have a gradual progression from low strenuous exercise to more strenuous training sessions. An example of this would be at the start of the intervention your son/daughter will use a strength training intensity of 50% of their one repetition maximum. Once they have adapted to this training intensity, it will be increased to 80% of their one repetition maximum. This will ensure that they do not over stress yourself and increase your risk of injury.

POSSIBLE BENEFITS

Your son/daughter will receive a 13 week training program designed by an NSCA certified strength coach who will take into account all aspects of designing a program for an elite athlete. While they may not directly benefit from participation in the study, their participation will help us to better understand how to improve sport performance in elite and recreational athletes.

EXCLUSION/WITHDRAWAL FROM THE STUDY

For the 13 week duration of this study, your son/daughter will not be permitted to participate in a strength training program outside of this study. Finally, if they are absent for 3 consecutive strength sessions or a total of 6 sessions over the 13 week study, they will no longer qualify for this study. At this time your son/daughter will be thanked for their participation and all information collected from them will be destroyed.

If your son/ daughter feel uncomfortable about any of the testing or strength training sessions they may leave the study at any time. If they choose to leave the study all information connected to them will be removed from the study and destroyed. Their participation in this study is completely voluntary and should they decide not to participate in any portion of the study their data will be removed, and they may do so without question or consequence. If they complete the study, they will no longer be able to remove your data from the study.

CONFIDENTIALITY & ANONYMITY

As your son/daughter will be exercising in a group full anonymity in this study is not possible. However, all measures will be taken to ensure that they will not be identifiable to others as a participant in this study. The data which will be collected is of a personal nature, since will be examining a variety of body weight, height, fat percent, strength and psychological measurements. If you or your son/daughter wish to have the body measurements done away from the group a private room is available, and only the Principal Investigator and/or research assistants will be present. Moreover, their test results will be kept strictly confidential and in no way will it be possible to link the results to them. Their name will not be used on any testing sheets or reports.

The Principal Investigator will be using a personal communication device (e.g., cell phone). However no other person other than the Principal Investigator has access or will answer this phone, as it is password protected. Additionally, no participant identifiable information will be stored on the device. Any information that is left on the phone will be destroyed upon the conclusion of the study.

The data collected will be stored on a password protected USB or hard drive and in a secure location that only the Principal Investigator or supervisors have access to. This consent form, and any other forms that contain personal information such as your name, will be stored in a locked filing cabinet, in a secure office within the Department of Kinesiology at Dalhousie University. It will be in a geographically separate location from all other data and never be used to identify participants. Your son/daughter will be assigned a number which is only used to organize their testing results for data analysis and in no way provide as a means to link the results to them. All data will be kept for seven years after completion of the study, as per Dalhousie University ethics requirements. After the seven years all data will be destroyed and disposed of in accordance to Dalhousie University regulations.

If you or your son/daughter disclose that they are/have been abused or neglected as a child (or vulnerable adult), they will be informed that the researchers are required by law to report this information to the authorities. Following the testing or training session the researcher will make a report with the appropriate authorities and inform the supervisor of their actions.

QUESTIONS

If there are any changes to this study, your son/daughter will be given this information as it might affect their decision to participate. If you/they have any questions throughout the duration of the testing or strength sessions about this study or their participation, please do not hesitate to ask the researcher. Should you/they have any questions following a session you/they may contact the principal investigator at (902) 452- 7683 or via e-mail at jesse.adams@dal.ca. Please note that if you/they live outside the Halifax Regional Municipality you/they may contact the Principal Investigator via e-mail.

PROBLEMS OR CONCERNS

If you or your son/daughter have any difficulties with, or wish to voice concern about, any aspect of their participation in this study, you/they may contact Catherine Connors at the Dalhousie Research Services Office at (902) 494-3423, ethics@dal.ca. Collect calls are always accepted.

SIGNATURE PAGE

The effects of mental focusing and motivational techniques on strength performance

I have read the explanation of this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent I will take part in this study. However I realize that my participation is voluntary and I am free to withdraw from the study at any time. I consent to my test results being recorded and stored on an encrypted password protected USB. Finally, I have received a copy of the consent form for my own records.

Participant Name:_____________________________

Legal Guardian Name:_____________________________

Legal Guardian/Participant Signature:____________________ Date:_________________

Principal Investigator Name:______________________________

Principal Investigator Signature:__________________________ Date:_________________

☐ I would like to receive a copy of my results in this study.

Please provide a complete mailing address in the space provided below if you would like to receive a copy of the study results.

PARTICIPANT ASSENT FORM (MOTOR IMAGERY GROUP)

PARTICIPANT ASSENT FORM IN THE STUDY:

The effects of mental focusing and motivational techniques on strength performance

My name is ______________________________________.

Over the next three months I will be working with Jesse Adams at the Canadian Sport Center Atlantic or Dalhousie University. He is a researcher in training athletes and would like to know if arousal techniques will affect strength. Jesse's research will start in September 2012 and end in December 2012 lasting a total of 12 weeks. During this time period I will not participate in any other type of strength training. I will undergo 4 testing sessions (1.5 hours each), along with 12 weeks of strength and mental focus or motivational technique training (1-1.5 hours each). The first two weeks will allow me to learn the different testing, training and motor imagery techniques. During the testing sessions I will be doing a maximal strength test for the upper and lower body, taking body measurements (i.e. height and weight) and completing a short questionnaire. The next 8 weeks will be the main strength training and the final 2 weeks will be a decrease in how much training I do using the same exercises. After these 12 weeks the final week there will be for the last testing session (total of 13 weeks). The amount and how hard the training is will keep changing so I do not get too tired or hurt myself. Doing this research will help them and other researchers to understand more about strength training in athletes and how to make their training programs better.

I decided I would like to be in this study. If I decide at any time that I no longer want to be in the experiment, I just have to tell Jesse and he will let me leave without any questions or consequences. I do understand that if I miss more than 6 total sessions or 3 sessions in a row I will no longer be able to take part in the study.

I know that Jesse and the other supervisors will do everything they can to make sure I will to get hurt. However I will be doing very hard exercises and there is a chance I could be hurt. If this happens Jesse and the other supervisors are trained to help me and they will take care of me in the best way possible. Finally, if I do get hurt I have to get a doctor’s note saying I am ok to exercise before returning to the study, if I do not I will not be able to be a part of the study any longer.

All of my “data” (scores, numbers, and any other information) collected from me over the next 3 months will remain confidential – that means no one (except Jesse, and the other researchers) will be able to know my name, or know that it was me who was in the experiment. In fact, instead of using my name, they will use a “secret code.” After seven years, all of my data, and anything with my name on it, will be destroyed.

If I have any questions, my parents or I can call Jesse at 902-452-7683.

Name: ____

Date:____

INFORMED CONSENT FOR EXIT INTERVIEW MOTOR IMAGERY GROUP

(YOU)

School of Human Health
and Performance

INFORMED CONSENT FORM

The effects of mental focusing and motivational techniques on strength performance: Exit interviews

Supervisors:

Dr. Carolyn Savoy	**Dr. Melanie Keats**
Department of Kinesiology	**Department of Kinesiology**
School of Human Health	**School of Human Health**
and Performance	**and Performance**
E-mail: carolyn.savoy@dal.ca	**Phone: (902) 494-7173**
	E-mail:melanie.keats@dal.ca

PRINCIPAL INVESTIGATOR:

Jesse Adams (MSc Candidate)
Principal Investigator

Department of Kinesiology
School of Human Health and Performance
Dalhousie University
6230 South Street
Halifax, NS. B3H 4R2

(902) 452-7683
Jesse.adams@dal.ca

School of Human Health and Performance, Department of Kinesiology, Dalhousie University, 6230 South Street, Halifax, NS, B3H 4R2
Phone: (902) 452-7683 E-mail: jesse.adams@dal.ca

INTRODUCTION

We invite you to take part in an exit interview for the original research study “The effects of mental focusing and motivational techniques on strength performance”. This interview will be done by Jesse Adams, who is an MSc candidate within the School of Human Health and Performance, in the Department of Kinesiology at Dalhousie University. Your participation in this additional portion of the study is entirely voluntary and you may choose not to participate or stop the interview at any time. The interview is described below and tells you about the potential risks, inconvenience, or discomfort which you may experience. Participating in the exit interview might not benefit you directly, but we might learn things that will benefit others. Should you have any questions about this study please contact the Principal Investigator, Jesse Adams.

PURPOSE OF THE STUDY

The purpose of the exit interviews is to learn more about your experiences in the 11 week strength training program that you recently completed.

STUDY DESIGN

The exit interview will be about 10 -15 minutes long and will ask you very general questions about your experience in the study. For example, did you find mental focusing or motivational techniques improved your overall training experience. Your responses to the interview questions will be audio recorded, transcribed and analyzed for general content regarding your experience.

WHO CAN PARTICIPATE IN THIS STUDY

You are able to participate in this study if you qualified and completed the study “The effects of mental focusing and motivational techniques on strength performance”. If you are 17 years of age or younger you require a parents permission to participate.

WHO WILL BE CONDUCTING THE RESEARCH

Jesse Adams the Principal Investigator for the study “The effects of mental focusing and motivational techniques on strength performance” will run the exit interview session. The Supervisors Dr. Savoy and Dr. Keats, will provide guidance to the Principal Investigator throughout the study.

WHAT WILL YOU BE ASKED TO DO

If you choose to participate, you will be asked to take part in 10-15 minute exit interview. General questions regarding your experience in the intervention will be asked. An example of the questions is (Did you find the use of motor imagery aided/hindered your upper/lower body strength, Why/why not? How did it or did not?). Your response will be recorded using a digital recorder.

POSSIBLE RISKS

Although unlikely, it is possible that you may become stressed (e.g., emotionally or psychologically) as a result of the exit interview. You will be recalling your experiences in the study, as such emotional distress may occur. In order to prevent this, the questions will be kept brief and very general. You also do not have to answer any questions that make you feel uncomfortable. You can also stop the interview at any time.

POSSIBLE BENEFITS

You may not directly benefit from participation in the study, however your participation will help us to better understand how to improve sport performance in elite and recreational athletes.

You may gain a further understanding of your experience in the research study. This may help with any future strength training you may engage in.

EXCLUSION/WITHDRAWAL FROM THE STUDY

If you feel uncomfortable about any of the questions you may stop the interview at any time. If you choose to leave the interview all information connected to you will be removed from the interview session and destroyed. Your participation in the interview is completely voluntary and should you decide not to participate in any portion of the interview your data will be removed, and you may do so without question or consequence. If you complete the interview, you will no longer be able to remove your data.

CONFIDENTIALITY & ANONYMITY

The interviews will be done in a separate room where no other participant will hear the responses to any of the questions. Your responses will not be identifiable in any way, as only general themes will be used in the final report. Should you allow us to use a direct quote, we will not identify you personally.

The data collected will be stored on a password protected USB or hard drive and in a secure location that only the Principal Investigator or supervisors have access to. This consent form, and any other forms that contain personal information such as your name, will be stored in a locked filing cabinet, in a secure office within the Department of Kinesiology at Dalhousie University. It will be in a geographically separate location from all other data and never be used to identify participants. You will be assigned a number which is only used to organize your testing results for data analysis and in no way provide as a means to link the results to you. All data will be kept for seven years after completion of the study, as per Dalhousie University ethics requirements. After the seven years all data will be destroyed and disposed of in accordance to Dalhousie University regulations.

If you disclose that you are/have been abused or neglected as a child (or vulnerable adult), you will be informed that the researchers are required by law to report this information to the authorities. Following the testing or training session the researcher will make a report with the appropriate authorities and inform the supervisor of their actions.

QUESTIONS

Should you have any questions regarding the interviews you may contact the principal investigator at (902) 452- 7683 or via e-mail at jesse.adams@dal.ca.

PROBLEMS OR CONCERNS

If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Catherine Connors at the Dalhousie Research Services Office at (902) 494-3423, ethics@dal.ca. Collect calls are always accepted.

SIGNATURE PAGE

The effects of mental focusing and motivational techniques on strength performance

I have read the explanation of this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent I will take part in this study. However I realize that my participation is voluntary and I am free to withdraw from the study at any time. I consent to my interview being audio recorded and stored on an encrypted password protected computer. Finally, I have received a copy of the consent form for my own records.

Participant Name:_____________________________

Legal Guardian Name:_____________________________

Legal Guardian/Participant Signature:______________________Date:_________________

☐ Yes, I agree to allow the investigators to use direct quotes.

Legal Guardian/Participant Signature:___________________ Date:_________________

Principal Investigator Name:_______________________________

Principal Investigator Signature:___________________________ Date:_________________

INFORMED CONSENT FOR EXIT INTERVIEW MOTOR IMAGERY GROUP

(YOU)

School of Human Health
and Performance

INFORMED CONSENT FORM

The effects of mental focusing and motivational techniques on strength performance: Exit interviews

Supervisors:

Dr. Carolyn Savoy
Department of Kinesiology
School of Human Health
and Performance
E-mail: carolyn.savoy@dal.ca

Dr. Melanie Keats
Department of Kinesiology
School of Human Health
and Performance
Phone: (902) 494-7173
E-mail:melanie.keats@dal.ca

PRINCIPAL INVESTIGATOR:

Jesse Adams (MSc Candidate)
Principal Investigator

Department of Kinesiology
School of Human Health and Performance
Dalhousie University
6230 South Street
Halifax, NS. B3H 4R2

(902) 452-7683
Jesse.adams@dal.ca

INTRODUCTION

We invite your son/daughter to take part in an exit interview for the original research study "The effects of mental focusing and motivational techniques on strength performance". This interview will be done by Jesse Adams, who is an MSc candidate within the School of Human Health and Performance, in the Department of Kinesiology at Dalhousie University. Your son/ daughter's participation in this additional portion of the study is entirely voluntary and your son/daughter may choose not to participate or stop the interview at any time. The interview is described below and tells you about the potential risks, inconvenience, or discomfort which your son/daughter may experience. Participating in the exit interview might not benefit them directly, but we might learn things that will benefit others. Should you or your son/daughter have any questions about this study please contact the Principal Investigator, Jesse Adams.

PURPOSE OF THE STUDY

The purpose of the exit interviews is to learn more about your son/daughter experiences in the 11 week strength training program that you recently completed.

STUDY DESIGN

The exit interview will be about 10 -15 minutes long and will ask them very general questions about your experience in the study. For example, did they find mental focusing or motivational techniques improved their overall training experience. Your son/ daughter's responses to the interview questions will be audio recorded, transcribed and analyzed for general content regarding your experience.

WHO CAN PARTICIPATE IN THIS STUDY

Your son/daughter is able to participate in this study if the qualified and completed the study "The effects of mental focusing and motivational techniques on strength performance". If your son/ daughter is 17 years of age or younger they will require a parents permission to participate.

WHO WILL BE CONDUCTING THE RESEARCH

Jesse Adams the Principal Investigator for the study "The effects of mental focusing and motivational techniques on strength performance" will run the exit interview session. The Supervisors Dr. Savoy and Dr. Keats, will provide guidance to the Principal Investigator throughout the study.

WHAT WILL YOU BE ASKED TO DO

If your son/ daughter choose to participate, they will be asked to take part in 10-15 minute exit interview. General questions regarding their experience in the intervention will be asked. An example of the questions is (Did they find the use motor imagery aided/hindered their upper/lower body strength, Why/why not? How did it or did not?). Their response will be recorded using a digital recorder.

POSSIBLE RISKS

Although unlikely, it is possible that your son/ daughter may become stressed (e.g., emotionally or psychologically) as a result of the exit interview. They will be recalling their experiences in the study, as such emotional distress may occur. In order to prevent this, the questions will be kept brief and very general. Your son/ daughter also do not have to answer any questions that make them feel uncomfortable. They can also stop the interview at any time.

POSSIBLE BENEFITS

Your son/ daughter may not directly benefit from participation in the study, however their participation will help us to better understand how to improve sport performance in elite and recreational athletes.

Your son/ daughter may gain a further understanding of their experience in the research study. This may help with any future strength training they may engage in.

EXCLUSION/WITHDRAWAL FROM THE STUDY

If they feel uncomfortable about any of the questions they may stop the interview at any time. If they choose to leave the interview all information connected to them will be removed from the interview session and destroyed. Their participation in the interview is completely voluntary and should they decide not to participate in any portion of the interview their data will be removed, and they may do so without question or consequence. If they complete the interview, they will no longer be able to remove their data.

CONFIDENTIALITY & ANONYMITY

The interviews will be done in a separate room where no other participant will hear the responses to any of the questions. Your son/ daughter's responses will not be identifiable in any way, as only general themes will be used in the final report. Should they allow us to use a direct quote, we will not identify them personally.

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Participant Name:___________________________

Legal Guardian Name:___________________________

Legal Guardian/Participant Signature:____________________Date:_________________

☐ Yes, I agree to allow the investigators to use direct quotes.

Legal Guardian/Participant Signature:__________________ Date:_________________

Principal Investigator Name:______________________________

Principal Investigator Signature:__________________________ Date:_________________

INFORMED CONSENT FORM MOTIVATIONAL MUSIC GROUP (YOU)

DALHOUSIE UNIVERSITY
Inspiring Minds

School of Human Health
and Performance

INFORMED CONSENT FORM

The effects of mental focusing and motivational techniques on strength performance

Supervisors:

Dr. Carolyn Savoy	**Dr. Melanie Keats**
Department of Kinesiology	**Department of Kinesiology**
School of Human Health	**School of Human Health**
and Performance	**and Performance**
E-mail: carolyn.savoy@dal.ca	**Phone: (902) 494-7173**
	E-mail:melanie.keats@dal.ca

PRINCIPAL INVESTIGATOR:

Jesse Adams (MSc Candidate)
Principal Investigator

Department of Kinesiology
School of Human Health and Performance
Dalhousie University
6230 South Street
Halifax, NS. B3H 4R2

(902) 452-7683
Jesse.adams@dal.ca

INTRODUCTION

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PURPOSE OF THE STUDY

The purpose of the proposed study is to understand the effect of two different forms of mental focusing combined with strength training on strength performance.

STUDY DESIGN

You have been randomly selected (e.g., similar to flipping a coin) to participate in a 13-week strength training program that includes listening to motivational music. Through the course of the study you will participate in testing sessions during weeks 1, 3, 10, 13. After each of the strength training sessions you will fill out a pen and paper questionnaire that will take 1 to 2 minutes.

TIME COMMITMENT				
Task	Time/ session (hrs)	Number of sessions	Number of weeks	Total number of sessions
Testing	1.5	4	Familiarization test: Week 1 Baseline test: Week 3 Pre-training decrease test: Week 10 Post intervention test: Week 13	4
Strength training	1-1.5	3	8	24
Reduced strength training	1-1.5	2	2	4
Total commitment	**55hrs**		**13**	**32 sessions**

WHO CAN PARTICIPATE IN THIS STUDY

You are able to participate in this study if you are a male or female, live in Nova Scotia, and have participated in competitive sport within the last two years. For the purpose of this study a competitive athlete is someone who participated in a sport where the primary goal is winning and practice to increase their skills/performance. You must be between the ages of 15 to 24. If you are 17 years of age or younger you require a parents signature.

WHO WILL BE CONDUCTING THE RESEARCH

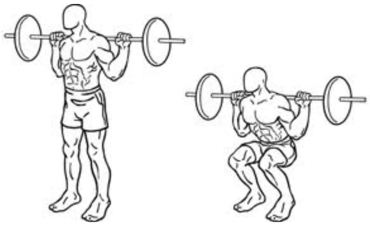
Jesse Adams the Principal Investigator for this study and will oversee the testing and strength sessions. The Research assistants (Director of sport science CSCA Leo Thornley MSc, CSCS; CSCA lead strength coach Darren Steeves, CSCS, MSc; CSCA strength and physiology consultant Scott Willgress, CSCS, MKin) are Certified Strength and Conditioning Specialist (CSCS) and currently work at the Canadian Sport Center Atlantic. The CSCA works with elite athletes ranging from 14 years of age (developmental athletes) to 35 years of age (Olympic athletes). The CSCA is responsible for the design of the athletes exercise programs. The research assistants will be involved in the implementation of testing or strength training sessions. Supervisors Dr. Savoy and Dr. Keats, will provide guidance to the Principal Investigator throughout the study.

WHAT WILL YOU BE ASKED TO DO

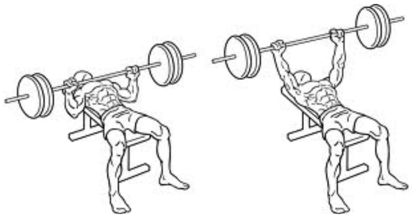
If you choose to participate you will be asked to take part in a 13 week strength training program from September 2012 to December 2012. During the 13 weeks you will complete four testing sessions, strength training and listen to motivational music while strength training. During all strength and testing sessions you will be asked to wear athletic clothing (shorts and a t-shirt) in order to properly perform all movements.

The fitness test includes body measurements like height, weight, body fat and size (e.g. width of the upper arm). Strength testing includes a one repetition maximum bench press and a three repetition maximum back squat (refer to the diagrams below for an example of both the bench press and back squat). Both tests will be done under the supervision of the Principal Investigator or Research Assistants. The supervisors will ensure proper supervision in order to aid in preventing any injury from occurring. During the body measurement portion of the testing, upon your request you will have access to a private room.

Back Squat



Bench Press



During the strength training sessions a variety of strength exercises will be used which will focus on both upper and lower body. An example of an upper body exercise is a dumbbell bench press. An example of a lower body exercise is the back squat. A National Strength and Conditioning (NSCA) certified strength and conditioning specialist (CSCS) will be present at all time during both the testing and training sessions. The NSCA is one of the most reputable governing bodies for strength and conditioning research. This will ensure maximum safety and proper technique is used to achieve optimal benefits from each strength exercise.

At the end of every strength session you will be asked to rate the perceived effectiveness of listening to motivational music on your strength training. These questions will take a total of 1 minute at the end of the strength training session. Additionally, your answers will be written on a piece of paper and placed in a locked box. The only thing that can identify you on the paper is your subject number, and the only people looking at the paper will be the Principal Investigator or Research Assistants.

POSSIBLE RISKS

It is possible that you may become stressed (e.g., physically, emotionally or psychologically) as a result of participating in this study. You will be doing strenuous strength training and this can result in injury (e.g., muscle strain, overuse injury, etc.). A NSCA certified strength coach will be present at all times to ensure proper technique and spotting. However, this does not guarantee that an injury will not occur.

If injury were to occur, all study staff are trained in Standard First Aid and CPR. Additionally, there are certified lifeguards in the Canada Games facility, and will be contacted if additional help is needed. Finally, if injury is severe 911 will be notified. If injured during the study a medical note must be presented to the Principal Investigator before continuing participation in the study. If medical approval is not given your participation in the study will be terminated and your all data will be removed.

Psychological or emotional distress (e.g., burnout) can also result from participating in physically strenuous exercises like strength training. However, these sessions will be monitored by the Principal Investigator and Research Assistants to decrease any potential risk of distress.

All sessions have been developed in accordance to academically accepted strength training models. The strength training will have gradual progression from low strenuous exercise to more strenuous training sessions. An example of this would be at the start of the intervention you will use a strength training intensity of 50% of your one repetition maximum. Once you have adapted to this training intensity, it will be increased to 80% of your one repetition maximum. This will ensure that you do not over stress yourself and increase your risk of injury.

POSSIBLE BENEFITS

You will receive a 13 week training program designed by an NSCA certified strength coach which will take into account all aspects of designing a program for an elite athlete. While you may not directly benefit from participation in the study, your participation will help us to better understand how to improve sport performance in elite and recreational athletes.

EXCLUSION/WITHDRAWAL FROM THE STUDY

For the 13 week duration of this study, you will not be permitted to participate in a strength training program outside of this study. Finally, if you are absent for 3 consecutive strength sessions or a total of 6 sessions over the 13 week study, you will no longer qualify for this study. At this time you will be thanked for your participation and all information collected from you will be destroyed.

If you feel uncomfortable about any of the testing or strength training sessions you may leave the study at any time. If you choose to leave the study all information connected to you will be removed from the study and destroyed. Your participation in this study is completely voluntary and should you decide not to participate in any portion of the study your data will be removed, and you may do so without question or consequence. If you complete the study, you will no longer be able to remove your data from the study.

CONFIDENTIALITY & ANONYMITY

As you will be exercising in a group full anonymity in this study is not possible. However, all measures will be taken to ensure that you will not be identifiable to others as a participant in this study. The data which will be collected is of a personal nature, since will be examining a variety of body weight, height, fat percent, strength and psychological measurements. If you wish to have the body measurements done away from the group a private room is available, and only the Principal Investigator and/or research assistants will be present. Moreover, your test results will be kept strictly confidential and in no way will it be possible to link the results to you. Your name will not be used on any testing sheets or reports.

The Principal Investigator will be using a personal communication device (e.g., cell phone). However no other person other than the Principal Investigator has access or will answer this phone, as it is password protected. Additionally, no participant identifiable information will be stored on the device. Any information that is left on the phone will be destroyed upon the conclusion of the study.

The data collected will be stored on a password protected USB or hard drive and in a secure location that only the Principal Investigator or supervisors have access to. This consent form, and any other forms that contain personal information such as your name, will be stored in a locked filing cabinet, in a secure office within the Department of Kinesiology at Dalhousie University. It will be in a geographically separate location from all other data and never be used to identify participants. You will be assigned a number which is only used to organize your testing results for data analysis and in no way provide as a means to link the results to you. All data will be kept for seven years after completion of the study, as per Dalhousie University ethics requirements. After the seven years all data will be destroyed and disposed of in accordance to Dalhousie University regulations.

If you disclose that you are/have been abused or neglected as a child (or vulnerable adult), you will be informed that the researchers are required by law to report this information to the authorities. Following the testing or training session the researcher will make a report with the appropriate authorities and inform the supervisor of their actions.

QUESTIONS

If there are any changes to this study, you will be given this information as it might affect your decision to participate. If you have any questions throughout the duration of the testing or strength sessions about this study or your participation, please do not hesitate to ask the researcher. Should you have any questions following a session you may contact the principal investigator at (902) 452- 7683 or via e-mail at jesse.adams@dal.ca. Please note that if you live outside the Halifax Regional Municipality you may contact the Principal Investigator via e-mail.

PROBLEMS OR CONCERNS

If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Catherine Connors at the Dalhousie Research Services Office at (902) 494-3423, ethics@dal.ca. Collect calls are always accepted.

SIGNATURE PAGE

The effects of mental focusing and motivational techniques on strength performance

I have read the explanation of this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent I will take part in this study. However I realize that my participation is voluntary and I am free to withdraw from the study at any time. I consent to my test results being recorded and stored on an encrypted password protected USB. Finally, I have received a copy of the consent form for my own records.

Participant Name:____________________________

Legal Guardian Name:____________________________

Legal Guardian/Participant Signature:____________________ Date:_________________

Principal Investigator Name:______________________________

Principal Investigator Signature:__________________________ Date:_________________

☐ I would like to receive a copy of my results in this study.

Please provide a complete mailing address in the space provided below if you would like to receive a copy of the study results.

INFORMED CONSENT FORM MOTIVATIONAL MUSIC GROUP (PARENT)

School of Human Health
and Performance

INFORMED CONSENT FORM

The effects of mental focusing and motivational techniques on strength performance

Supervisors:

Dr. Carolyn Savoy
Department of Kinesiology
School of Human Health
and Performance
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PRINCIPAL INVESTIGATOR:

Jesse Adams (MSc Candidate)
Principal Investigator

Department of Kinesiology
School of Human Health and Performance
Dalhousie University
6230 South Street
Halifax, NS. B3H 4R2

(902) 452-7683
Jesse.adams@dal.ca

INTRODUCTION

We invite your son/daughter to take part in a research study being done by Jesse Adams, within the School of Human Health and Performance, Department of Kinesiology at Dalhousie University. Their participation in this study is entirely voluntary and they may leave the study at any time. The study is described below and tells you about the potential risks, inconvenience, or discomfort which your son/daughter may experience. Participating in this study might not benefit them directly, but we might learn things that will benefit others. Should you have any questions about this study please contact the Principal Investigator, Jesse Adams.

PURPOSE OF THE STUDY

The purpose of the proposed study is to understand the effect of two different forms of mental focusing combined with strength training on strength performance.

STUDY DESIGN

Your son/daughter have been randomly selected (e.g., similar to flipping a coin) to participate in a 13-week strength training program that includes listening to motivational music. Through the course of the study they will participate in testing sessions during weeks 1, 3, 10, 13. After each of the strength training sessions they will fill out a pen and paper questionnaire that will take 1 to 2 minutes.

<table>
<tr><th colspan="5">TIME COMMITMENT</th></tr>
<tr><th>Task</th><th>Time/ session (hrs)</th><th>Number of sessions</th><th>Number of weeks</th><th>Total number of sessions</th></tr>
<tr><td>Testing</td><td>1.5</td><td>4</td><td>Familiarization test: Week 1
Baseline test: Week 3
Pre-training decrease test: Week 10
Post intervention test: Week 13</td><td>4</td></tr>
<tr><td>Strength training</td><td>1-1.5</td><td>3</td><td>8</td><td>24</td></tr>
<tr><td>Reduced strength training</td><td>1-1.5</td><td>2</td><td>2</td><td>4</td></tr>
<tr><td>Total commitment</td><td>55hrs</td><td></td><td>13</td><td>32 sessions</td></tr>
</table>

WHO CAN PARTICIPATE IN THIS STUDY

Your son/daughter are able to participate in this study if they are a male or female, live in Nova Scotia, and have participated in competitive sport within the last two years. For the purpose of this study a competitive athlete is someone who participated in a sport where the primary goal is winning and practice to increase their skills/performance. Your son/daughter must be between the ages of 15 to 24. If they are 17 years of age or younger they require a parents signature.

WHO WILL BE CONDUCTING THE RESEARCH

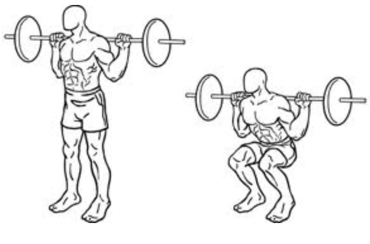
Jesse Adams the Principal Investigator for this study and will oversee the testing and strength sessions. The Research assistants (Director of sport science CSCA Leo Thornley MSc, CSCS; CSCA lead strength coach Darren Steeves, CSCS, MSc; CSCA strength and physiology consultant Scott Willgress, CSCS, MKin) are Certified Strength and Conditioning Specialist (CSCS) and currently work at the Canadian Sport Center Atlantic. The CSCA works with elite athletes ranging from 14 years of age (developmental athletes) to 35 years of age (Olympic athletes). The CSCA is responsible for the design of the athletes exercise programs. The research assistants will be involved in the implementation of testing or strength training sessions. Supervisors Dr. Savoy and Dr. Keats, will provide guidance to the Principal Investigator throughout the study.

WHAT YOUR SON/DAUGHTER WILL BE ASKED TO DO

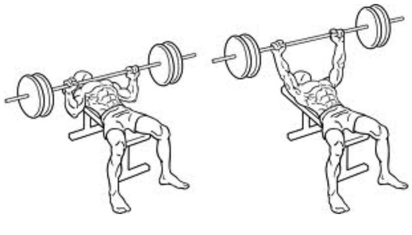
If your son/daughter chooses to participate in they will be asked to take part in a 13 week strength training program from September 2012 to December 2012. During the 13 weeks they will complete four testing sessions, strength training and listen to motivational music. During all strength and testing sessions your son/daughter will be asked to wear athletic clothing (shorts and a t-shirt) in order to properly perform all movements.

The fitness test includes body measurements like height, weight, body fat and size (e.g. width of the upper arm). Strength testing includes a one repetition maximum bench press and a three repetition maximum back squat (refer to the diagrams below for an example of both the bench press and back squat). Both tests will be done under the supervision of the Principal Investigator or Research Assistants. The supervisors will ensure proper supervision in order to aid in preventing any injury from occurring. During the body measurement portion of the testing, upon yours or your son/daughter’s request they will have access to a private room.

Back Squat



Bench Press



During the strength training sessions a variety of strength exercises will be used which will focus on both upper and lower body. An example of an upper body exercise is a dumbbell bench press. An example of a lower body exercise is the back squat. A National Strength and Conditioning (NSCA) certified strength and conditioning specialist (CSCS) will be present at all time during both the testing and training sessions. The NSCA is one of the most reputable governing bodies for strength and conditioning research. This will ensure maximum safety and proper technique is used to achieve optimal benefits from each strength exercise.

At the end of every strength session your son/daughter will be asked to rate the perceived effectiveness of how listening to motivational music helped their strength training. These questions will take a total of 1 minute at the end of the strength training session. Additionally, their answers will be written on a piece of paper and placed in a locked box. The only thing that can identify your son/daughter on the paper is their subject number, and the only people looking at the paper will be the Principal Investigator or Research Assistants.

POSSIBLE RISKS

It is possible that your son/daughter may become stressed (e.g., physically, emotionally or psychologically) as a result of participating in this study. They will be doing strenuous strength training and this can result in injury (e.g., muscle strain, overuse injury, etc.). A NSCA certified strength coach will be present at all times to ensure proper technique and spotting. However, this does not guarantee that an injury will not occur.

If injury were to occur, all study staff are trained in Standard First Aid and CPR. Additionally, there are certified lifeguards in the Canada Games facility, and will be contacted if additional help is needed. Finally, if injury is severe 911 will be notified. If injured during the study a medical note must be presented to the Principal Investigator before continuing participation in the study. If medical approval is not given your son/daughters' participation in the study will be terminated and their all data will be removed.

Psychological or emotional distress (e.g., burnout) can also result from participating in physically strenuous exercises like strength training. However, these sessions will be monitored by the Principal Investigator and Research Assistants to decrease any potential risk of distress.

All sessions have been developed in accordance to academically accepted strength training models. The strength training will have gradual progression from low strenuous exercise to more strenuous training sessions. An example of this would be at the start of the intervention your son/daughter will use a strength training intensity of 50% of their one repetition maximum. Once they have adapted to this training intensity, it will be increased to 80% of their one repetition maximum. This will ensure that they do not over stress yourself and increase your risk of injury.

POSSIBLE BENEFITS

Your son/daughter will receive a 13 week training program designed by an NSCA certified strength coach who will take into account all aspects of designing a program for an elite athlete. While they may not directly benefit from participation in the study, their participation will help us to better understand how to improve sport performance in elite and recreational athletes.

EXCLUSION/WITHDRAWAL FROM THE STUDY

For the 13 week duration of this study, your son/daughter will not be permitted to participate in a strength training program outside of this study. Finally, if they are absent for 3 consecutive strength sessions or a total of 6 sessions over the 13 week study, they will no longer qualify for this study. At this time your son/daughter will be thanked for their participation and all information collected from them will be destroyed.

If your son/ daughter feel uncomfortable about any of the testing or strength training sessions they may leave the study at any time. If they choose to leave the study all information connected to them will be removed from the study and destroyed. Their participation in this study is completely voluntary and should they decide not to participate in any portion of the study their data will be removed, and they may do so without question or consequence. If they complete the study, they will no longer be able to remove your data from the study.

CONFIDENTIALITY & ANONYMITY

As your son/daughter will be exercising in a group full anonymity in this study is not possible. However, all measures will be taken to ensure that they will not be identifiable to others as a participant in this study. The data which will be collected is of a personal nature, since will be examining a variety of body weight, height, fat percent, strength and psychological measurements. If you or your son/daughter wish to have the body measurements done away from the group a private room is available, and only the Principal Investigator and/or research assistants will be present. Moreover, their test results will be kept strictly confidential and in no way will it be possible to link the results to them. Their name will not be used on any testing sheets or reports.

The Principal Investigator will be using a personal communication device (e.g., cell phone). However no other person other than the Principal Investigator has access or will answer this phone, as it is password protected. Additionally, no participant identifiable information will be stored on the device. Any information that is left on the phone will be destroyed upon the conclusion of the study.

The data collected will be stored on a password protected USB or hard drive and in a secure location that only the Principal Investigator or supervisors have access to. This consent form, and any other forms that contain personal information such as your name, will be stored in a locked filing cabinet, in a secure office within the Department of Kinesiology at Dalhousie University. It will be in a geographically separate location from all other data and never be used to identify participants. Your son/daughter will be assigned a number which is only used to organize their testing results for data analysis and in no way provide as a means to link the results to them. All data will be kept for seven years after completion of the study, as per Dalhousie University ethics requirements. After the seven years all data will be destroyed and disposed of in accordance to Dalhousie University regulations.

If you or your son/daughter disclose that they are/have been abused or neglected as a child (or vulnerable adult), they will be informed that the researchers are required by law to report this information to the authorities. Following the testing or training session the researcher will make a report with the appropriate authorities and inform the supervisor of their actions.

QUESTIONS

If there are any changes to this study, your son/daughter will be given this information as it might affect their decision to participate. If you/they have any questions throughout the duration of the testing or strength sessions about this study or their participation, please do not hesitate to ask the researcher. Should you/they have any questions following a session you/they may contact the principal investigator at (902) 452- 7683 or via e-mail at jesse.adams@dal.ca. Please note that if you/they live outside the Halifax Regional Municipality you/they may contact the Principal Investigator via e-mail.

PROBLEMS OR CONCERNS

If you or your son/daughter have any difficulties with, or wish to voice concern about, any aspect of their participation in this study, you/they may contact Catherine Connors at the Dalhousie Research Services Office at (902) 494-3423, ethics@dal.ca. Collect calls are always accepted.

SIGNATURE PAGE

The effects of mental focusing and motivational techniques on strength performance

I have read the explanation of this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent I will take part in this study. However I realize that my participation is voluntary and I am free to withdraw from the study at any time. I consent to my test results being recorded and stored on an encrypted password protected USB. Finally, I have received a copy of the consent form for my own records.

Participant Name:____________________________

Legal Guardian Name:____________________________

Legal Guardian/Participant Signature:____________________ Date:_________________

Principal Investigator Name:______________________________

Principal Investigator Signature:__________________________ Date:_________________

☐ I would like to receive a copy of my results in this study.

Please provide a complete mailing address in the space provided below if you would like to receive a copy of the study results.

PARTICIPANT ASSENT FORM (MOTIVATIONAL MUSIC)

PARTICIPANT ASSENT FORM IN THE STUDY:

The effects of mental focusing and motivational techniques on strength performance

My name is _____________________________________.

Over the next three months I will be working with Jesse Adams at the Canadian Sport Center Atlantic or Dalhousie University. He is a researcher in training athletes and would like to know if arousal techniques will affect strength. Jesse's research will start in September 2012 and end in December 2012 lasting a total of 12 weeks. During this time period I will not participate in any other type of strength training. I will undergo 4 testing sessions (1.5 hours each), along with 12 weeks of strength and mental focus or motivational technique training (1-1.5 hours each). The first two weeks will allow me to learn the different testing, training and motivational music techniques. During the testing sessions I will be doing a maximal strength test for the upper and lower body, taking body measurements (i.e. height and weight) and completing a short questionnaire. The next 8 weeks will be the main strength training and the final 2 weeks will be a decrease in how much training I do using the same exercises. After these 12 weeks the final week there will be for the last testing session (total of 13 weeks). The amount and how hard the training is will keep changing so I do not get too tired or hurt myself. Doing this research will help them and other researchers to understand more about strength training in athletes and how to make their training programs better.

I decided I would like to be in this study. If I decide at any time that I no longer want to be in the experiment, I just have to tell Jesse and he will let me leave without any questions or consequences. I do understand that if I miss more than 6 total sessions or 3 sessions in a row I will no longer be able to take part in the study.

I know that Jesse and the other supervisors will do everything they can to make sure I will to get hurt. However I will be doing very hard exercises and there is a chance I could be hurt. If this happens Jesse and the other supervisors are trained to help me and they will take care of me in the best way possible. Finally, if I do get hurt I have to get a doctor's note saying I am ok to exercise before returning to the study, if I do not I will not be able to be a part of the study any longer.

All of my "data" (scores, numbers, and any other information) collected from me over the next 3 months will remain confidential – that means no one (except Jesse, and the other researchers) will be able to know my name, or know that it was me who was in the experiment. In fact, instead of using my name, they will use a "secret code." After seven years, all of my data, and anything with my name on it, will be destroyed.

If I have any questions, my parents or I can call Jesse at 902-452-7683.

Name: ____

Date:____

INFORMED CONSENT FOR EXIT INTERVIEW MOTIVATIONAL MUSIC (YOU)

School of Human Health
and Performance

INFORMED CONSENT FORM

The effects of mental focusing and motivational techniques on strength performance: Exit interviews

Supervisors:

Dr. Carolyn Savoy	**Dr. Melanie Keats**
Department of Kinesiology	**Department of Kinesiology**
School of Human Health	**School of Human Health**
and Performance	**and Performance**
E-mail: carolyn.savoy@dal.ca	**Phone: (902) 494-7173**
	E-mail:melanie.keats@dal.ca

PRINCIPAL INVESTIGATOR:

Jesse Adams (MSc Candidate)
Principal Investigator

Department of Kinesiology
School of Human Health and Performance
Dalhousie University
6230 South Street
Halifax, NS. B3H 4R2

(902) 452-7683
Jesse.adams@dal.ca

School of Human Health and Performance, Department of Kinesiology, Dalhousie University, 6230 South Street, Halifax, NS, B3H 4R2
Phone: (902) 452-7683 E-mail: jesse.adams@dal.ca

INTRODUCTION

We invite you to take part in an exit interview for the original research study “The effects of mental focusing and motivational techniques on strength performance”. This interview will be done by Jesse Adams, who is an MSc candidate within the School of Human Health and Performance, in the Department of Kinesiology at Dalhousie University. Your participation in this additional portion of the study is entirely voluntary and you may choose not to participate or stop the interview at any time. The interview is described below and tells you about the potential risks, inconvenience, or discomfort which you may experience. Participating in the exit interview might not benefit you directly, but we might learn things that will benefit others. Should you have any questions about this study please contact the Principal Investigator, Jesse Adams.

PURPOSE OF THE STUDY

The purpose of the exit interviews is to learn more about your experiences in the 11 week strength training program that you recently completed.

STUDY DESIGN

The exit interview will be about 10 -15 minutes long and will ask you very general questions about your experience in the study. For example, did you find mental focusing or motivational techniques improved your overall training experience. Your responses to the interview questions will be audio recorded, transcribed and analyzed for general content regarding your experience.

WHO CAN PARTICIPATE IN THIS STUDY

You are able to participate in this study if you qualified and completed the study “The effects of mental focusing and motivational techniques on strength performance”. If you are 17 years of age or younger you require a parents permission to participate.

WHO WILL BE CONDUCTING THE RESEARCH

Jesse Adams the Principal Investigator for the study “The effects of mental focusing and motivational techniques on strength performance” will run the exit interview session. The Supervisors Dr. Savoy and Dr. Keats, will provide guidance to the Principal Investigator throughout the study.

WHAT WILL YOU BE ASKED TO DO

If you choose to participate, you will be asked to take part in 10-15 minute exit interview. General questions regarding your experience in the intervention will be asked. An example of the questions is (Did you find the use motivational music aided/hindered your upper/lower body strength, Why/why not? How did it or did not?). Your response will be recorded using a digital recorder.

POSSIBLE RISKS

Although unlikely, it is possible that you may become stressed (e.g., emotionally or psychologically) as a result of the exit interview. You will be recalling your experiences in the study, as such emotional distress may occur. In order to prevent this, the questions will be kept brief and very general. You also do not have to answer any questions that make you feel uncomfortable. You can also stop the interview at any time.

POSSIBLE BENEFITS

You may not directly benefit from participation in the study, however your participation will help us to better understand how to improve sport performance in elite and recreational athletes.

You may gain a further understanding of your experience in the research study. This may help with any future strength training you may engage in.

EXCLUSION/WITHDRAWAL FROM THE STUDY

If you feel uncomfortable about any of the questions you may stop the interview at any time. If you choose to leave the interview all information connected to you will be removed from the interview session and destroyed. Your participation in the interview is completely voluntary and should you decide not to participate in any portion of the interview your data will be removed, and you may do so without question or consequence. If you complete the interview, you will no longer be able to remove your data.

CONFIDENTIALITY & ANONYMITY

The interviews will be done in a separate room where no other participant will hear the responses to any of the questions. Your responses will not be identifiable in any way, as only general themes will be used in the final report. Should you allow us to use a direct quote, we will not identify you personally.

The data collected will be stored on a password protected USB or hard drive and in a secure location that only the Principal Investigator or supervisors have access to. This consent form, and any other forms that contain personal information such as your name, will be stored in a locked filing cabinet, in a secure office within the Department of Kinesiology at Dalhousie University. It will be in a geographically separate location from all other data and never be used to identify participants. You will be assigned a number which is only used to organize your testing results for data analysis and in no way provide as a means to link the results to you. All data will be kept for seven years after completion of the study, as per Dalhousie University ethics requirements. After the seven years all data will be destroyed and disposed of in accordance to Dalhousie University regulations.

If you disclose that you are/have been abused or neglected as a child (or vulnerable adult), you will be informed that the researchers are required by law to report this information to the authorities. Following the testing or training session the researcher will make a report with the appropriate authorities and inform the supervisor of their actions.

QUESTIONS

Should you have any questions regarding the interviews you may contact the principal investigator at (902) 452- 7683 or via e-mail at jesse.adams@dal.ca.

PROBLEMS OR CONCERNS

If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Catherine Connors at the Dalhousie Research Services Office at (902) 494-3423, ethics@dal.ca. Collect calls are always accepted.

SIGNATURE PAGE

The effects of mental focusing and motivational techniques on strength performance

I have read the explanation of this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent I will take part in this study. However I realize that my participation is voluntary and I am free to withdraw from the study at any time. I consent to my interview being audio recorded and stored on an encrypted password protected computer. Finally, I have received a copy of the consent form for my own records.

Participant Name:____________________________

Legal Guardian Name:____________________________

Legal Guardian/Participant Signature:_________________ Date:_________________

☐ Yes, I agree to allow the investigators to use direct quotes.

Legal Guardian/Participant Signature:__________________ Date:_________________

Principal Investigator Name:______________________________

Principal Investigator Signature:__________________________ Date:_________________

INFORMED CONSENT FOR EXIT INTERVIEW MOTIVATIONAL MUSIC

(PARENTAL)

School of Human Health
and Performance

INFORMED CONSENT FORM

The effects of mental focusing and motivational techniques on strength performance: Exit interviews

Supervisors:

Dr. Carolyn Savoy	**Dr. Melanie Keats**
Department of Kinesiology	**Department of Kinesiology**
School of Human Health	**School of Human Health**
and Performance	**and Performance**
E-mail: carolyn.savoy@dal.ca	**Phone: (902) 494-7173**
	E-mail:melanie.keats@dal.ca

PRINCIPAL INVESTIGATOR:

Jesse Adams (MSc Candidate)
Principal Investigator

Department of Kinesiology
School of Human Health and Performance
Dalhousie University
6230 South Street
Halifax, NS. B3H 4R2

(902) 452-7683
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Phone: (902) 452-7683 E-mail: jesse.adams@dal.ca

INTRODUCTION

We invite your son/daughter to take part in an exit interview for the original research study "The effects of mental focusing and motivational techniques on strength performance". This interview will be done by Jesse Adams, who is an MSc candidate within the School of Human Health and Performance, in the Department of Kinesiology at Dalhousie University. Your son/ daughter's participation in this additional portion of the study is entirely voluntary and your son/daughter may choose not to participate or stop the interview at any time. The interview is described below and tells you about the potential risks, inconvenience, or discomfort which your son/daughter may experience. Participating in the exit interview might not benefit them directly, but we might learn things that will benefit others. Should you or your son/daughter have any questions about this study please contact the Principal Investigator, Jesse Adams.

PURPOSE OF THE STUDY

The purpose of the exit interviews is to learn more about your son/daughter experiences in the 11 week strength training program that you recently completed.

STUDY DESIGN

The exit interview will be about 10 -15 minutes long and will ask them very general questions about your experience in the study. For example, did they find mental focusing or motivational techniques improved their overall training experience. Your son/ daughter's responses to the interview questions will be audio recorded, transcribed and analyzed for general content regarding your experience.

WHO CAN PARTICIPATE IN THIS STUDY

Your son/daughter is able to participate in this study if the qualified and completed the study "The effects of mental focusing and motivational techniques on strength performance". If your son/ daughter is 17 years of age or younger they will require a parents permission to participate.

WHO WILL BE CONDUCTING THE RESEARCH

Jesse Adams the Principal Investigator for the study "The effects of mental focusing and motivational techniques on strength performance" will run the exit interview session. The Supervisors Dr. Savoy and Dr. Keats, will provide guidance to the Principal Investigator throughout the study.

WHAT WILL YOU BE ASKED TO DO

If your son/ daughter choose to participate, they will be asked to take part in 10-15 minute exit interview. General questions regarding their experience in the intervention will be asked. An example of the questions is (Did they find the use motivational music aided/hindered their upper/lower body strength, Why/why not? How did it or did not?). Their response will be recorded using a digital recorder.

POSSIBLE RISKS

Although unlikely, it is possible that your son/ daughter may become stressed (e.g., emotionally or psychologically) as a result of the exit interview. They will be recalling their experiences in the study, as such emotional distress may occur. In order to prevent this, the questions will be kept brief and very general. Your son/ daughter also do not have to answer any questions that make them feel uncomfortable. They can also stop the interview at any time.

POSSIBLE BENEFITS

Your son/ daughter may not directly benefit from participation in the study, however their participation will help us to better understand how to improve sport performance in elite and recreational athletes.

Your son/ daughter may gain a further understanding of their experience in the research study. This may help with any future strength training they may engage in.

EXCLUSION/WITHDRAWAL FROM THE STUDY

If they feel uncomfortable about any of the questions they may stop the interview at any time. If they choose to leave the interview all information connected to them will be removed from the interview session and destroyed. Their participation in the interview is completely voluntary and should they decide not to participate in any portion of the interview their data will be removed, and they may do so without question or consequence. If they complete the interview, they will no longer be able to remove their data.

CONFIDENTIALITY & ANONYMITY

The interviews will be done in a separate room where no other participant will hear the responses to any of the questions. Your son/ daughter’s responses will not be identifiable in any way, as only general themes will be used in the final report. Should they allow us to use a direct quote, we will not identify them personally.

The data collected will be stored on a password protected USB or hard drive and in a secure location that only the Principal Investigator or supervisors have access to. This consent form, and any other forms that contain personal information such as your name, will be stored in a locked filing cabinet, in a secure office within the Department of Kinesiology at Dalhousie University. It will be in a geographically separate location from all other data and never be used to identify participants. You will be assigned a number which is only used to organize your testing results for data analysis and in no way provide as a means to link the results to you. All data will be kept for seven years after completion of the study, as per Dalhousie University ethics requirements. After the seven years all data will be destroyed and disposed of in accordance to Dalhousie University regulations.

If your son/daughter disclose that they are/have been abused or neglected as a child (or vulnerable adult), they will be informed that the researchers are required by law to report this information to the authorities. Following the testing or training session the researcher will make a report with the appropriate authorities and inform the supervisor of their actions.

QUESTIONS

Should you have any questions regarding the interviews you may contact the principal investigator at (902) 452- 7683 or via e-mail at jesse.adams@dal.ca.

PROBLEMS OR CONCERNS

If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Catherine Connors at the Dalhousie Research Services Office at (902) 494-3423, ethics@dal.ca. Collect calls are always accepted.

SIGNATURE PAGE

The effects of mental focusing and motivational techniques on strength performance

I have read the explanation of this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent I will take part in this study. However I realize that my participation is voluntary and I am free to withdraw from the study at any time. I consent to my interview being audio recorded and stored on an encrypted password protected computer. Finally, I have received a copy of the consent form for my own records.

Participant Name:____________________________

Legal Guardian Name:____________________________

Legal Guardian/Participant Signature:_________________ Date:_________________

☐ Yes, I agree to allow the investigators to use direct quotes.

Legal Guardian/Participant Signature:__________________ Date:_________________

Principal Investigator Name:______________________________

Principal Investigator Signature:__________________________ Date:_________________

APPENDIX D

CSCA LIABILITY WAIVER

Canadian Sport Centre
Centre canadien multisport
Atlantic/Atlantique

Committed to supporting high performance athletes in Atlantic Canada

RELEASE OF LIABILITY, WAIVER OF CLAIMS, ASSUMPTION OF RISKS AND INDEMNITY AGREEMENT **IN SIGNING THIS DOCUMENT YOU WILL WAIVER CERTAIN LEGAL RIGHTS, INCLUDING THE RIGHT TO SUE** ***PLEASE READ CAREFULLY!***	Initial

TO: CSCA

Name	Last	First and initial
Address	Street	City, Province and Postal Code

ASSUMPTION OF RISKS

I acknowledge that participation in a strength and conditioning program and fitness testing has many inherent risks, dangers and hazards and that while I am participating in a strength and conditioning program, I am exposed to and have full knowledge of the nature and extent of such risks, dangers and hazards, which include but are not limited to abnormal blood pressure; fainting; disorders of heart rhythm; heart attack, stroke or other cerebrovascular incident or occurrence; mental, physiological, motor, visual or hearing injuries, difficulties, deficiencies or disturbances; partial or total paralysis; slips, falls or other unintended loss of balance or bodily movement related to walking which may cause muscular, neurological, orthopedic, or other bodily injury; and other occurrences which could cause bodily injury, impairment, disability or death.

I FREELY ACCEPT AND FULLY ASSUME ALL SUCH RISKS, DANGERS AND HAZARDS AND THE POSSIBILITY OF PERSONAL INJURY, DEATH, PROPERTY DAMAGE AND LOSS RESULTING THEREFROM.

RELEASE OF LIABILITY, WAIVER OF CLAIMS AND INDEMNITY AGREEMENT

In consideration of approval to participate in the fitness testing program, I agree as follows:

1. **TO WAIVE ANY AND ALL CLAIMS** that I have or may in the future have against CSCA, its directors, officers, employees, agents, representatives, successors and assigns (hereinafter collectively referred to as "THE RELEASEES"), and **TO RELEASE THE RELEASEES** jointly and severally, of and from any and all liability for any losses, damages, expenses and claims arising out of or in connection with injury (including death) or damage to property that I may suffer, or that my next of kin may suffer as a result of my participation in the fitness testing program due to any cause whatsoever INCLUDING NEGLIGENCE, BREACH OF CONTRACT, OR BREACH OF ANY STATUTORY OR OTHER DUTY OF CARE.

2. **TO HOLD HARMLESS AND INDEMNIFY THE RELEASEES** from any and all liability for any loss, expenses, damages, demands and claims arising out of or in connection with injuries (including death) or damages to any and all persons and to any and all property, in any way sustained or alleged to have been sustained as a result of activities in which I engage which are beyond the scope of those activities approved by CSCA.

3. This agreement shall be effective and binding upon my heirs, next of kin, executors, administrators and representatives, in the event of my death or incapacity. This Agreement shall be governed by and interpreted solely in accordance with the laws of Nova Scotia.

I HAVE READ AND UNDERSTAND THIS AGREEMENT AND I AM AWARE THAT BY SIGNING THIS AGREEMENT I AM WAIVING CERTAIN LEGAL RIGHTS WHICH I OR MY HEIRS, NEXT OF KIN, EXECUTORS, ADMINISTRATORS AND REPRESENTATIVES MAY HAVE AGAINST THE RELEASEES.

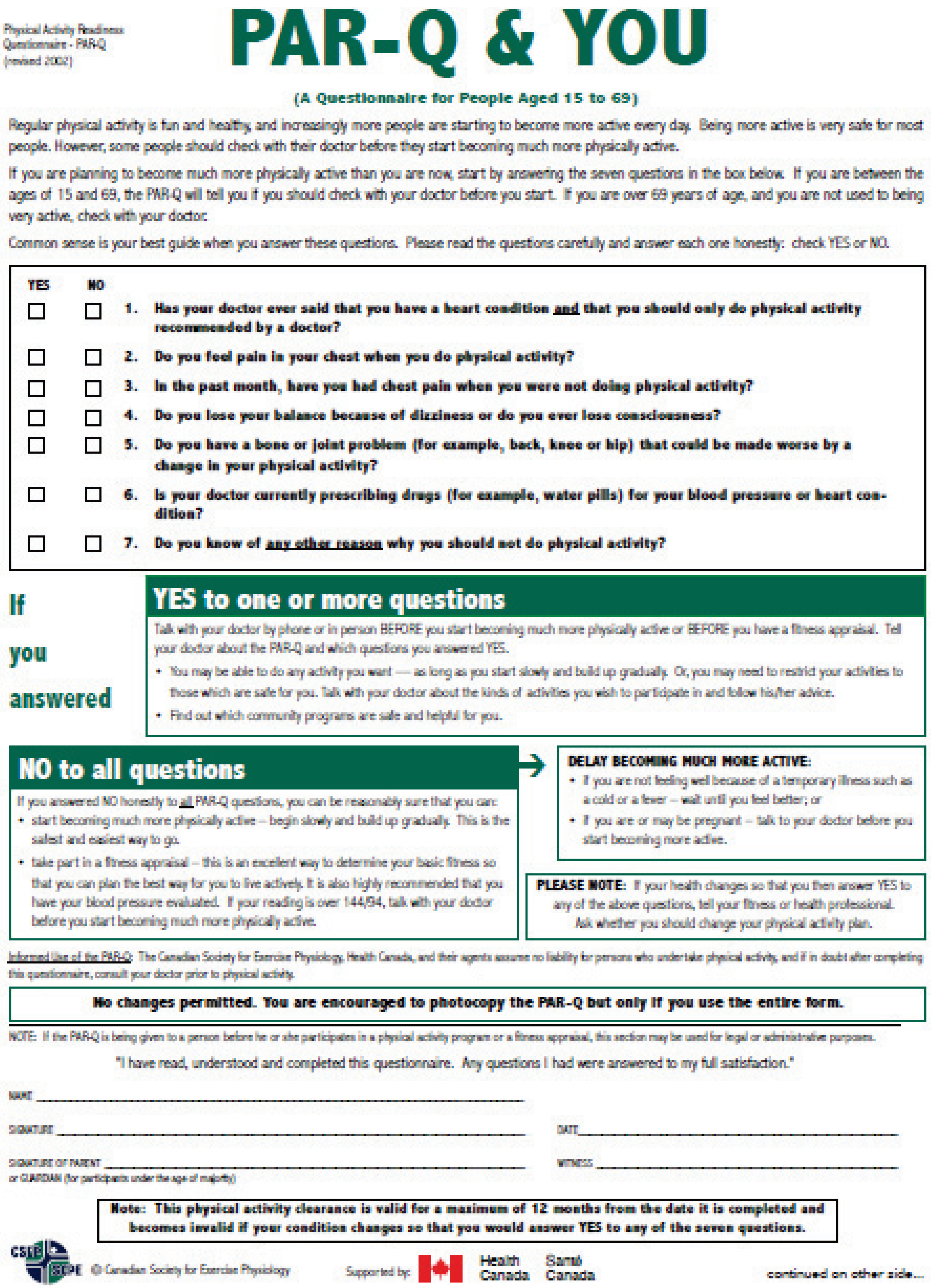
Signed at _______________, in the Province of ________________ this _____

day of ___________, 2011.

Signature	Witness
Please print name clearly	Please print name clearly
Signature of Legal Guardian where participant is under 18 years	Relation to Minor
Please print name clearly	

Please note- this Agreement must be completed in full, signed, dated and witnessed and the box at the top must be initialed before you may participate in the fitness testing program.

PAR-Q QUESTIONNAIRE



Physical Activity Readiness
Questionnaire - PAR-Q
(revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO		
☐	☐	1.	**Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	2.	**Do you feel pain in your chest when you do physical activity?**
☐	☐	3.	**In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	4.	**Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	5.	**Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	6.	**Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	7.	**Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- If you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- If you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME ______________________________

SIGNATURE ______________________________ DATE ______________________

SIGNATURE OF PARENT ______________________________ WITNESS ______________________
or GUARDIAN (for participants under the age of majority)

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

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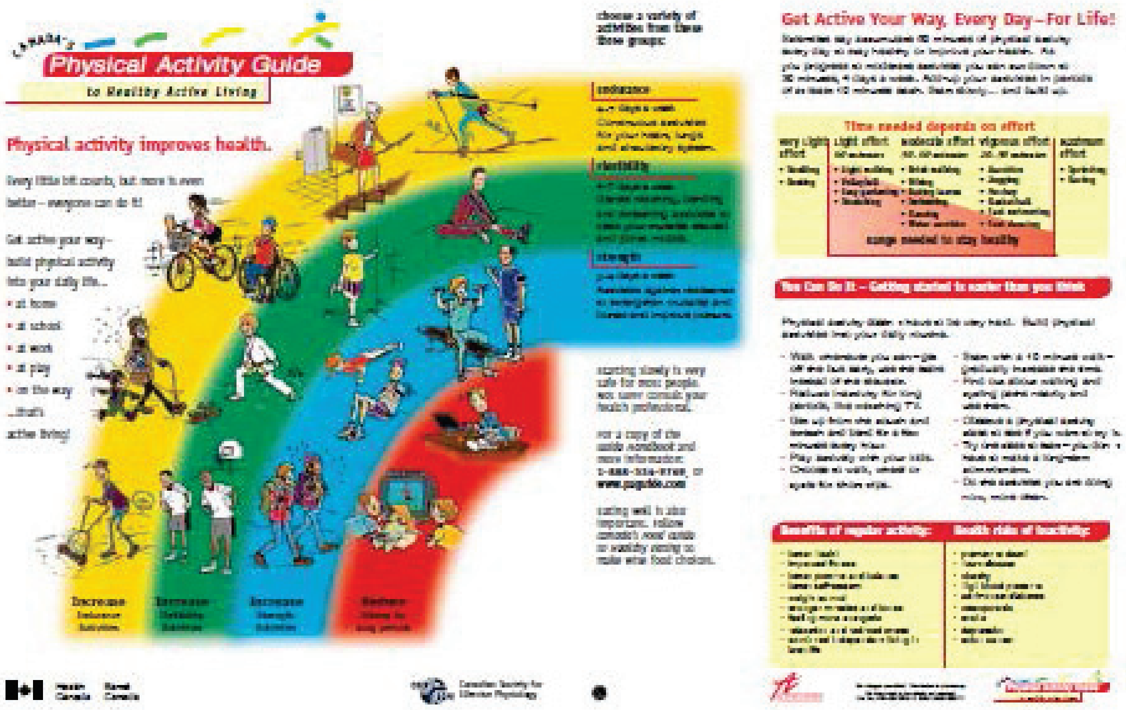
PAR-Q & YOU

Physical Activity Readiness
Questionnaire - PAR-Q
(revised 2002)



Source: Canada's Physical Activity Guide to Healthy Active Living, Health Canada, 1998 http://www.hc-sc.gc.ca/hppb/paguide/pdf/guideEng.pdf
© Reproduced with permission from the Minister of Public Works and Government Services Canada, 2002.

FITNESS AND HEALTH PROFESSIONALS MAY BE INTERESTED IN THE INFORMATION BELOW:

The following companion forms are available for doctors' use by contacting the Canadian Society for Exercise Physiology (address below):

The **Physical Activity Readiness Medical Examination (PARmed-X)** – to be used by doctors with people who answer YES to one or more questions on the PAR-Q.

The **Physical Activity Readiness Medical Examination for Pregnancy (PARmed-X for Pregnancy)** – to be used by doctors with pregnant patients who wish to become more active.

References:
Arraix, G.A., Wigle, D.T., Mao, Y. (1992). Risk Assessment of Physical Activity and Physical Fitness in the Canada Health Survey Follow-Up Study. **J. Clin. Epidemiol.** 45:4 419-428.
Mottola, M., Wolfe, L.A. (1994). Active Living and Pregnancy, In: A. Quinney, L. Gauvin, T. Wall (eds.), **Toward Active Living: Proceedings of the International Conference on Physical Activity, Fitness and Health.** Champaign, IL: Human Kinetics.
PAR-Q Validation Report, British Columbia Ministry of Health, 1978.
Thomas, S., Reading, J., Shephard, R.J. (1992). Revision of the Physical Activity Readiness Questionnaire (PAR-Q). **Can. J. Spt. Sci.** 17:4 338-345.

For more information, please contact the:

Canadian Society for Exercise Physiology
202-185 Somerset Street West
Ottawa, ON K2P 0J2
Tel. 1-877-651-3755 • FAX (613) 234-3565
Online: www.csep.ca

The original PAR-Q was developed by the British Columbia Ministry of Health. It has been revised by an Expert Advisory Committee of the Canadian Society for Exercise Physiology chaired by Dr. N. Gledhill (2002).

Disponible en français sous le titre «Questionnaire sur l'aptitude à l'activité physique - Q-AAP (revisé 2002)».

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APPENDIX E

REVISED MOVEMENT IMAGERY QUESTIONNAIRE

MOVEMENT IMAGERY QUESTIONNAIRE – REVISED (MIQ-R)

Craig R. Hall and Kathleen A. Martin, 1997

RATING SCALES

Visual Imagery Scale

1	2	3	4	5	6	7
Very Easy to See	Easy to see	Somewhat easy to see	Neutral	Somewhat hard to see	Hard to see	Very hard to see

Kinesthetic Imagery Scale

1	2	3	4	5	6	7
Very Easy to feel	Easy to feel	Somewhat easy to feel	Neutral	Somewhat hard to feel	Hard to see	Very hard to feel

MOVEMENT IMAGERY QUESTIONNAIRE REVISED TEST ITEMS

STARTING POSITION: Stand with your feet and legs together and your arms at your sides.

ACTION: Raise your right knee as high as possible so that you are standing on your left leg with your right leg flexed (bent) at the knee. Now lower your right leg so that you are again standing on two feet. Perform these actions slowly.

MENTAL TASK: Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.

Visual Rating	Kinesthetic Rating

STARTING POSITION: Stand with your feet slightly apart and your hands at your sides.

ACTION: Bend down low and then jump straight up in the air as high as possible with both arms extended above the head. Land with your feet apart and lower your arms to your sides.

MENTAL TASK: Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.

Visual Rating	Kinesthetic Rating

STARTING POSITION: Extend the arm of your non dominant hand straight out to your side so that it is parallel to the ground, palm down.

ACTION: Move your arm forward until it is directly in front of your body (still parallel to the ground). Keep your arm extended during the movement and make the movement slowly.

MENTAL TASK: Assume the starting position. Attempt to feel yourself making the movement just performed without actually doing it. Now rate the ease/difficulty with which you were able to do this mental task.

Visual Rating	Kinesthetic Rating

STARTING POSITION: Stand with your feet slightly apart and your arms fully extended above your head.

ACTION: Slowly bend forward at the waist and try and touch your toes with your fingertips (or if possible, touch the floor with your fingertips or hands). Now return to the starting position, standing erect with your arms extended above your head.

MENTAL TASK: Assume the starting position. Attempt to see yourself making the movement just performed with as clear and vivid a visual image as possible. Now rate the ease/difficulty with which you were able to do this mental task.

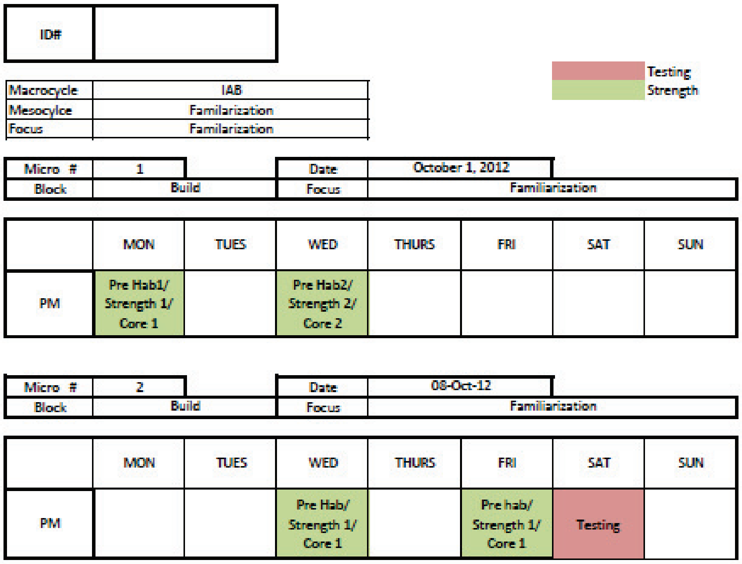
Visual Rating	Kinesthetic Rating

APPENDIX F

STRENGTH INTERVENTION OVERVIEW

Thesis Mock YTP												
	Months	Oct					Nov				Dec	
	Weekday	1	8	15	22	29	5	12	19	26	3	10
		Familiarization Test	Familiarization Training	Baseline Test Start program			Adaptation				Post Test	Pre Comp Taper
MACRO		FTP		STP								TP
	MESO	Fam		Base	Hyper.			Max Strength				Rec /MI
	Mesocycle #	1		2	3			4				5
	Microcycle #	1	2	3	4	5	6	7	8	9	10	11
	Micro Focus	F	B	B	H	H	A	S	S	S	S	R
	Test	■		■							■	■
	Compete											
	Over reaching - 100									■	■	
	Attack - 80				■	■		■	■	■	■	
	Build - 60	■	■	■	■	■		■	■	■	■	
	Adapt - 40	■	■	■	■	■	■	■	■	■	■	
	Recovery - 20	■	■	■	■	■	■	■	■	■	■	■
Strength Training												
(Priority)	General		🟦	🟦								
🟦 Main Priority	Strength		🟥	🟥				🟦	🟦	🟦	🟦	🟥
🟥 Second Priority	Muscular Hypertrophy				🟦	🟦						

FAMILIARIZATION TRAINING PHASE OVERVIEW



ID#	

🟥 Testing
🟩 Strength

Macrocycle	IAB
Mesocylce	Familarization
Focus	Familarization

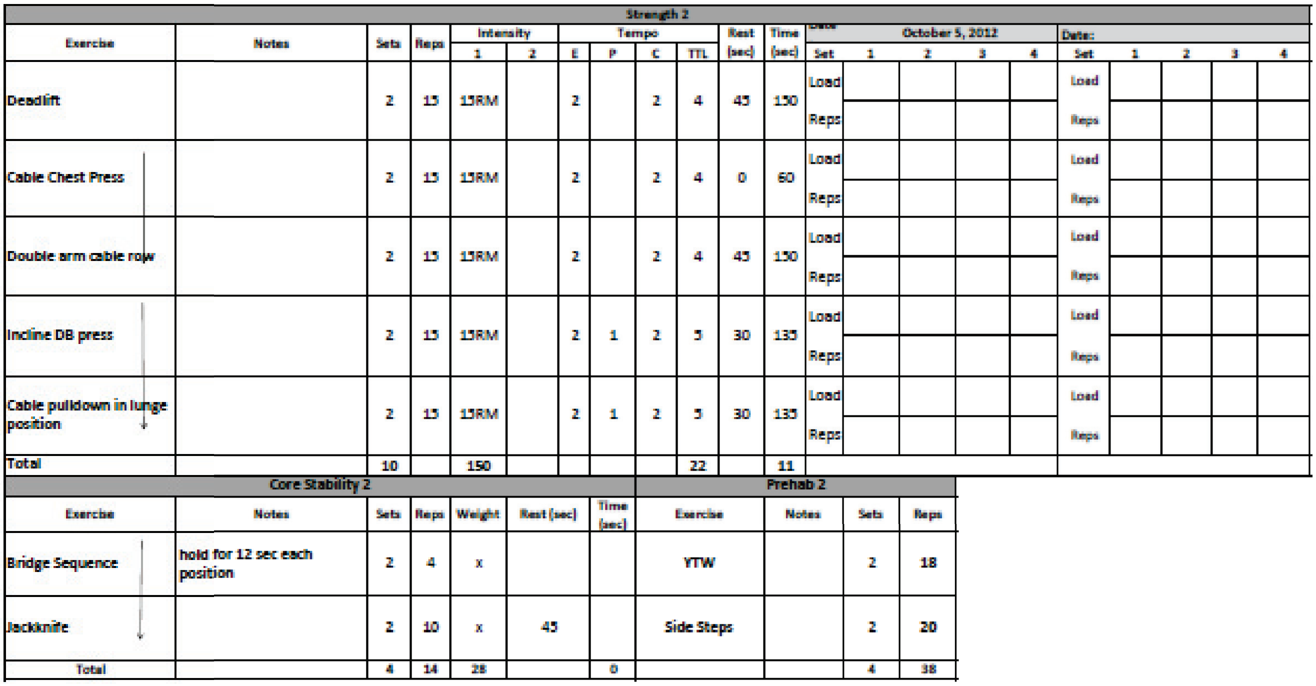
Micro #	1	Date	October 1, 2012
Block	Build	Focus	Familiarization

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Pre Hab1/ Strength 1/ Core 1		Pre Hab2/ Strength 2/ Core 2				

Micro #	2	Date	08-Oct-12
Block	Build	Focus	Familiarization

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM			Pre Hab/ Strength 1/ Core 1		Pre hab/ Strength 1/ Core 1	Testing	

Week 1

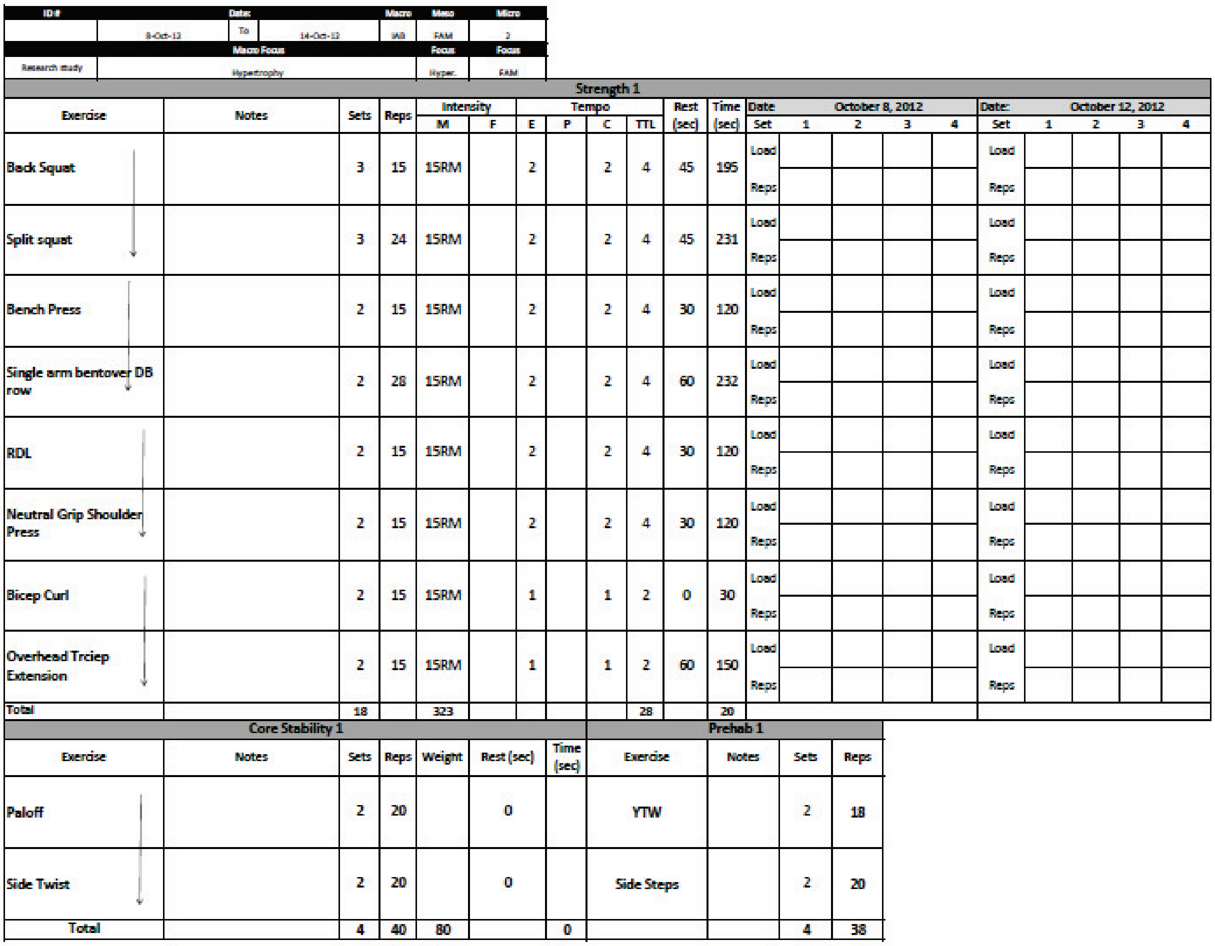


Strength 2																					
Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date	October 5, 2012				Date:				
				1	2	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Deadlift		2	15	15RM		2		2	4	45	150	Load					Load				
												Reps					Reps				
Cable Chest Press		2	15	15RM		2		2	4	0	60	Load					Load				
												Reps					Reps				
Double arm cable row		2	15	15RM		2		2	4	45	150	Load					Load				
												Reps					Reps				
Incline DB press		2	15	15RM		2	1	2	5	30	135	Load					Load				
												Reps					Reps				
Cable pulldown in lunge position		2	15	15RM		2	1	2	5	30	135	Load					Load				
												Reps					Reps				
Total		10		150					22		11										

Core Stability 2							Prehab 2			
Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)	Exercise	Notes	Sets	Reps
Bridge Sequence	hold for 12 sec each position	2	4	x			YTW		2	18
Jackknife		2	10	x	45		Side Steps		2	20
Total		4	14	28		0			4	38

Produced By: Jesse Adams BKin, COKA, C

Week 2



ID#	Date:			Macro	Meso	Micro
	8-Oct-12	To	14-Oct-12	IAB	FAM	2
	Macro Focus				Focus	Focus
Research study	Hypertrophy				Hyper.	FAM

Strength 1

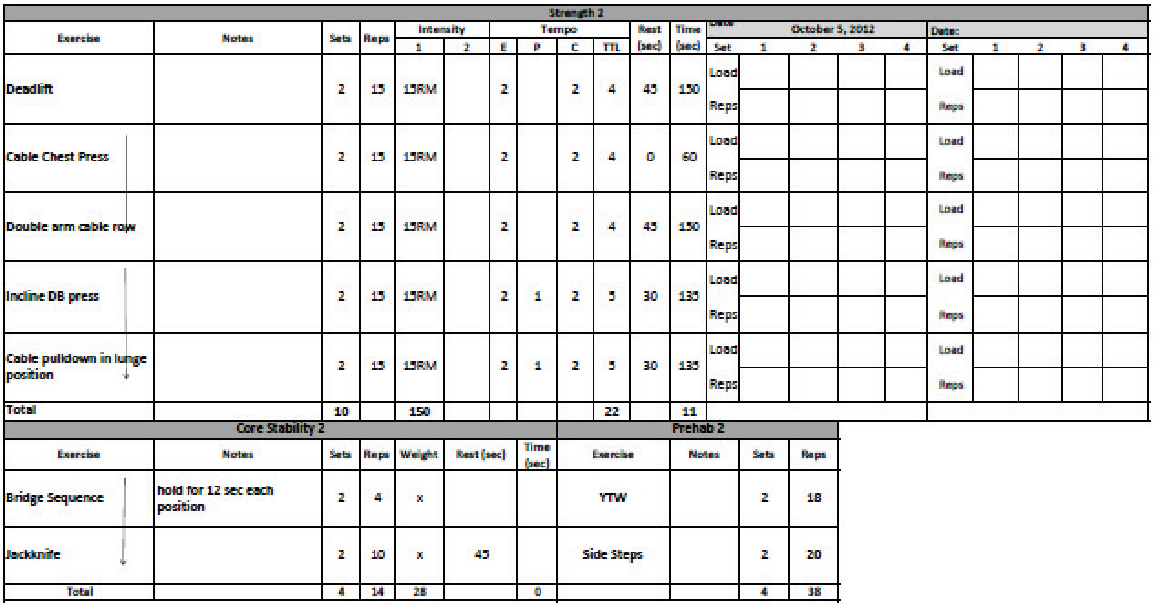
Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date	October 8, 2012				Date:	October 12, 2012			
				M	F	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Back Squat		3	15	15RM		2		2	4	45	195	Load					Load				
												Reps					Reps				
Split squat		3	24	15RM		2		2	4	45	231	Load					Load				
												Reps					Reps				
Bench Press		2	15	15RM		2		2	4	30	120	Load					Load				
												Reps					Reps				
Single arm bentover DB row		2	28	15RM		2		2	4	60	232	Load					Load				
												Reps					Reps				
RDL		2	15	15RM		2		2	4	30	120	Load					Load				
												Reps					Reps				
Neutral Grip Shoulder Press		2	15	15RM		2		2	4	30	120	Load					Load				
												Reps					Reps				
Bicep Curl		2	15	15RM		1		1	2	0	30	Load					Load				
												Reps					Reps				
Overhead Trciep Extension		2	15	15RM		1		1	2	60	150	Load					Load				
												Reps					Reps				
Total		18		323					28		20										

Core Stability 1

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Paloff		2	20		0	
Side Twist		2	20		0	
Total		4	40	80		0

Prehab 1

Exercise	Notes	Sets	Reps
YTW		2	18
Side Steps		2	20
		4	38



Strength 2

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)		October 5, 2012				Date:				
				1	2	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Deadlift		2	15	15RM		2		2	4	45	150	Load					Load				
												Reps					Reps				
Cable Chest Press		2	15	15RM		2		2	4	0	60	Load					Load				
												Reps					Reps				
Double arm cable row		2	15	15RM		2		2	4	45	150	Load					Load				
												Reps					Reps				
Incline DB press		2	15	15RM		2	1	2	5	30	135	Load					Load				
												Reps					Reps				
Cable pulldown in lunge position		2	15	15RM		2	1	2	5	30	135	Load					Load				
												Reps					Reps				
Total		10		150					22		11										

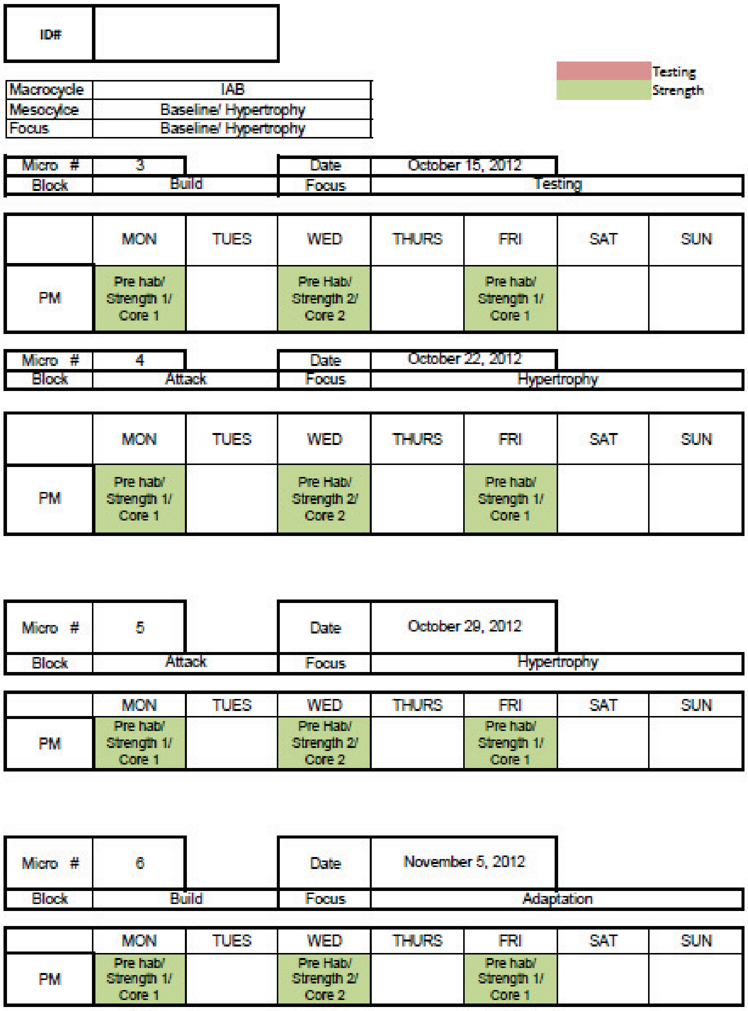
Core Stability 2

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Bridge Sequence	hold for 12 sec each position	2	4	x		
Jackknife		2	10	x	45	
Total		4	14	28		0

Prehab 2

Exercise	Notes	Sets	Reps
YTW		2	18
Side Steps		2	20
		4	38

STRENGTH TRAINING PHASE OVERVIEW (WEEKS 3-6)



ID#	

🟥	Testing
🟩	Strength

Macrocycle	IAB
Mesocylce	Baseline/ Hypertrophy
Focus	Baseline/ Hypertrophy

Micro #	3	Date	October 15, 2012
Block	Build	Focus	Testing

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Pre hab/ Strength 1/ Core 1		Pre Hab/ Strength 2/ Core 2		Pre hab/ Strength 1/ Core 1		

Micro #	4	Date	October 22, 2012
Block	Attack	Focus	Hypertrophy

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Pre hab/ Strength 1/ Core 1		Pre Hab/ Strength 2/ Core 2		Pre hab/ Strength 1/ Core 1		

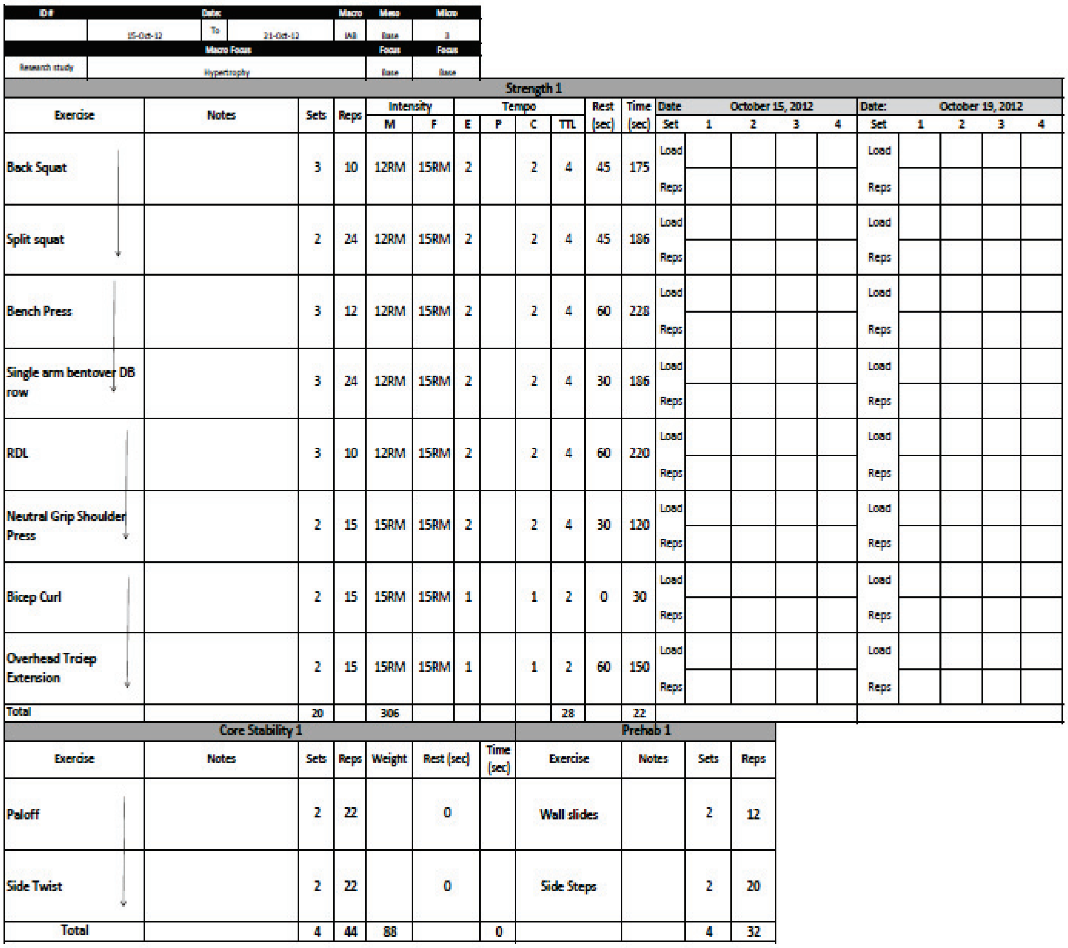
Micro #	5	Date	October 29, 2012
Block	Attack	Focus	Hypertrophy

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Pre hab/ Strength 1/ Core 1		Pre Hab/ Strength 2/ Core 2		Pre hab/ Strength 1/ Core 1		

Micro #	6	Date	November 5, 2012
Block	Build	Focus	Adaptation

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Pre hab/ Strength 1/ Core 1		Pre Hab/ Strength 2/ Core 2		Pre hab/ Strength 1/ Core 1		

Week 3



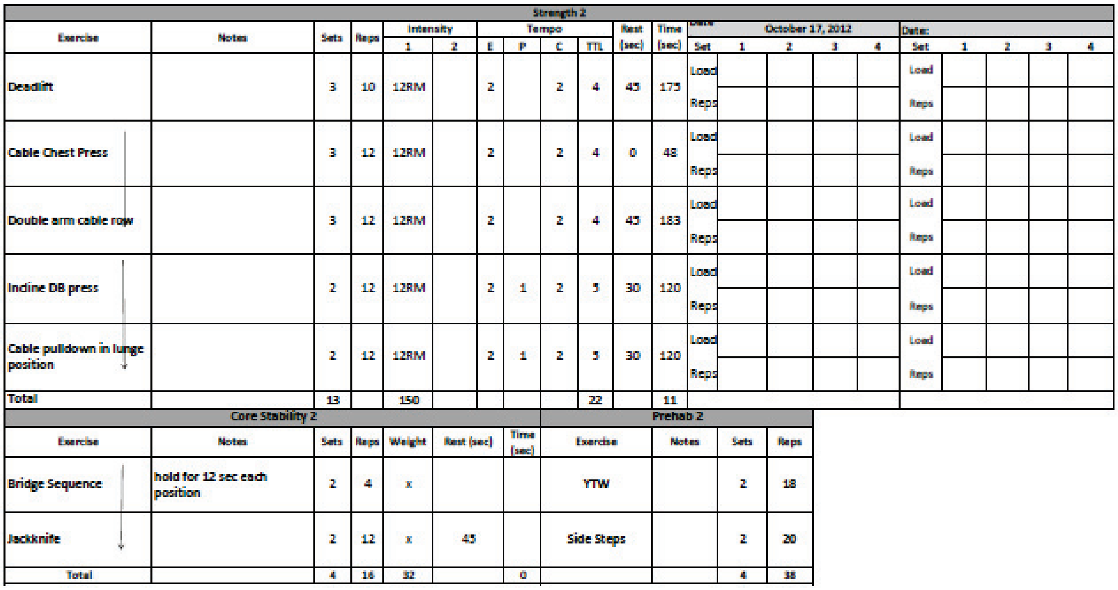
ID#	Date:			Macro	Meso	Micro
	15-Oct-12	To	21-Oct-12	IAB	Base	3
	Macro Focus				Focus	Focus
Research study	Hypertrophy				Base	Base

Strength 1

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest	Time	Date	October 15, 2012				Date:	October 19, 2012			
				M	F	E	P	C	TTL	(sec)	(sec)	Set	1	2	3	4	Set	1	2	3	4
Back Squat		3	10	12RM	15RM	2		2	4	45	175	Load					Load				
												Reps					Reps				
Split squat		2	24	12RM	15RM	2		2	4	45	186	Load					Load				
												Reps					Reps				
Bench Press		3	12	12RM	15RM	2		2	4	60	228	Load					Load				
												Reps					Reps				
Single arm bentover DB row		3	24	12RM	15RM	2		2	4	30	186	Load					Load				
												Reps					Reps				
RDL		3	10	12RM	15RM	2		2	4	60	220	Load					Load				
												Reps					Reps				
Neutral Grip Shoulder Press		2	15	15RM	15RM	2		2	4	30	120	Load					Load				
												Reps					Reps				
Bicep Curl		2	15	15RM	15RM	1		1	2	0	30	Load					Load				
												Reps					Reps				
Overhead Trciep Extension		2	15	15RM	15RM	1		1	2	60	150	Load					Load				
												Reps					Reps				
Total		20		306					28		22										

Core Stability 1							Prehab 1			
Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)	Exercise	Notes	Sets	Reps
Paloff		2	22		0		Wall slides		2	12
Side Twist		2	22		0		Side Steps		2	20
Total		4	44	88		0			4	32

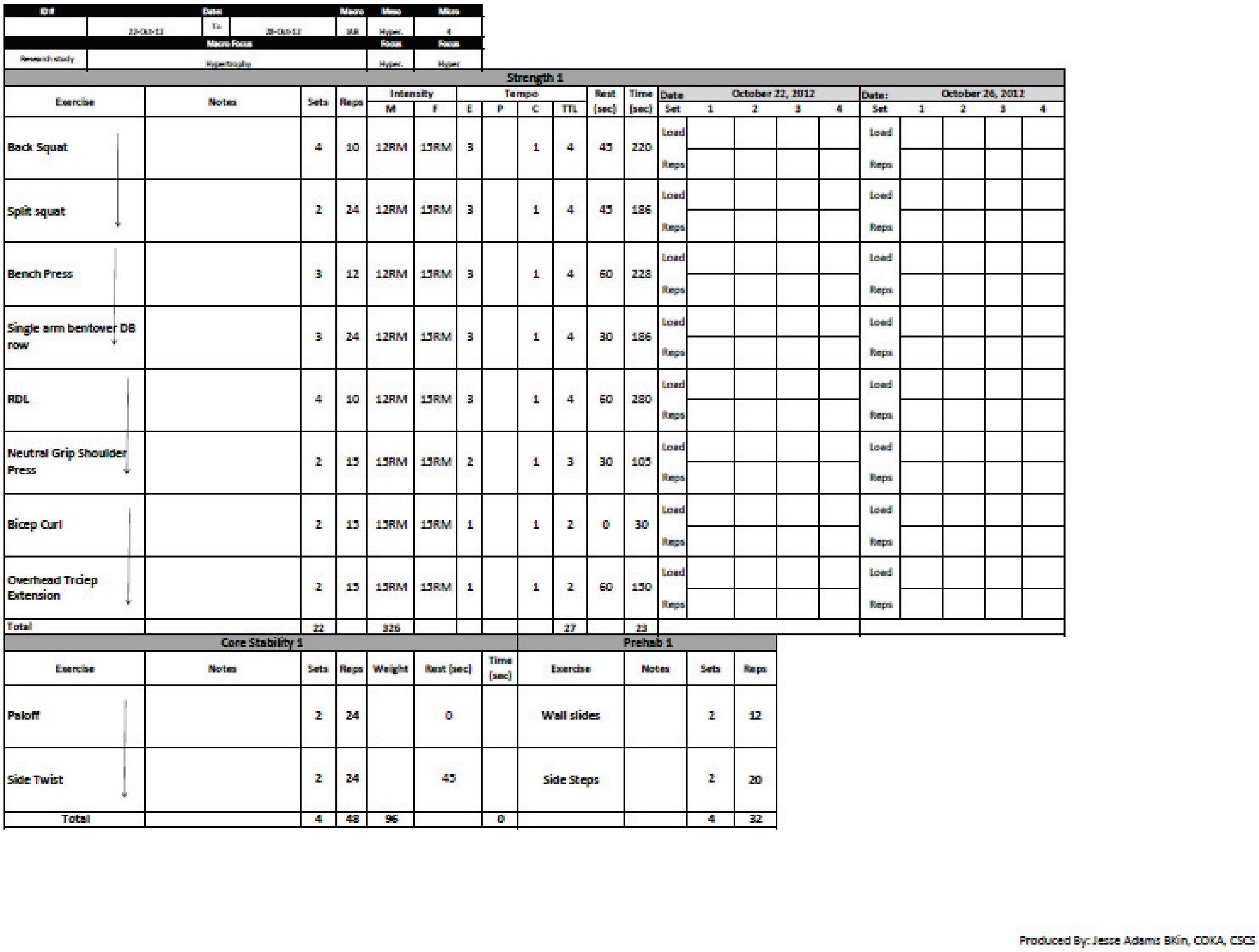
Produced By: Jesse Adams BKin, COKA, CSCS



Strength 2																					
Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	October 17, 2012					Date:				
				1	2	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Deadlift		3	10	12RM		2		2	4	45	175	Load					Load				
												Reps					Reps				
Cable Chest Press		3	12	12RM		2		2	4	0	48	Load					Load				
												Reps					Reps				
Double arm cable row		3	12	12RM		2		2	4	45	183	Load					Load				
												Reps					Reps				
Incline DB press		2	12	12RM		2	1	2	5	30	120	Load					Load				
												Reps					Reps				
Cable pulldown in lunge position		2	12	12RM		2	1	2	5	30	120	Load					Load				
												Reps					Reps				
Total		13		150					22		11										

Core Stability 2							Prehab 2			
Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)	Exercise	Notes	Sets	Reps
Bridge Sequence	hold for 12 sec each position	2	4	x			YTW		2	18
Jackknife		2	12	x	45		Side Steps		2	20
Total		4	16	32		0			4	38

Week 4



ID#	Date			Macro	Meso	Micro
	22-Oct-12	To	28-Oct-12	IAB	Hyper.	4
	Macro Focus				Focus	Focus
Research study	Hypertrophy				Hyper.	Hyper

Strength 1

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest	Time	Date	October 22, 2012				Date:	October 26, 2012			
				M	F	E	P	C	TTL	(sec)	(sec)	Set	1	2	3	4	Set	1	2	3	4
Back Squat		4	10	12RM	15RM	3		1	4	45	220	Load					Load				
												Reps					Reps				
Split squat		2	24	12RM	15RM	3		1	4	45	186	Load					Load				
												Reps					Reps				
Bench Press		3	12	12RM	15RM	3		1	4	60	228	Load					Load				
												Reps					Reps				
Single arm bentover DB row		3	24	12RM	15RM	3		1	4	30	186	Load					Load				
												Reps					Reps				
RDL		4	10	12RM	15RM	3		1	4	60	280	Load					Load				
												Reps					Reps				
Neutral Grip Shoulder Press		2	15	15RM	15RM	2		1	3	30	105	Load					Load				
												Reps					Reps				
Bicep Curl		2	15	15RM	15RM	1		1	2	0	30	Load					Load				
												Reps					Reps				
Overhead Trciep Extension		2	15	15RM	15RM	1		1	2	60	150	Load					Load				
												Reps					Reps				
Total		22		326					27		23										

Core Stability 1							Prehab 1			
Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)	Exercise	Notes	Sets	Reps
Paloff		2	24		0		Wall slides		2	12
Side Twist		2	24		45		Side Steps		2	20
Total		4	48	96		0			4	32

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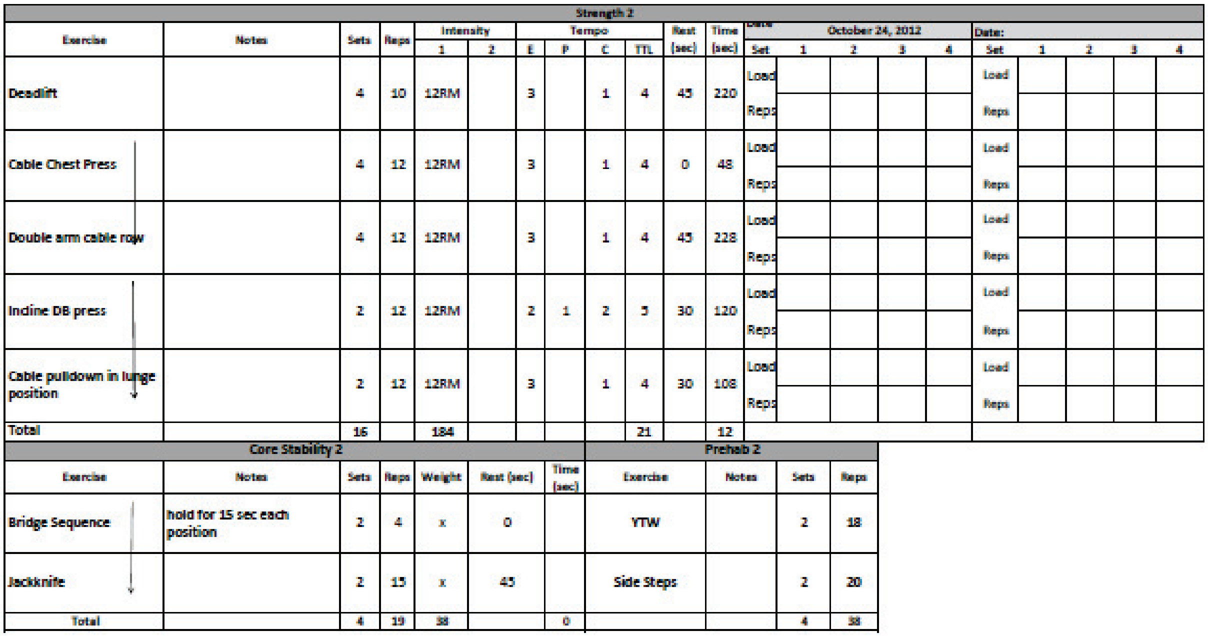


Strength 2

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date	October 24, 2012				Date:				
				1	2	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Deadlift		4	10	12RM		3		1	4	45	220	Load					Load				
												Reps					Reps				
Cable Chest Press		4	12	12RM		3		1	4	0	48	Load					Load				
												Reps					Reps				
Double arm cable row		4	12	12RM		3		1	4	45	228	Load					Load				
												Reps					Reps				
Incline DB press		2	12	12RM		2	1	2	5	30	120	Load					Load				
												Reps					Reps				
Cable pulldown in lunge position		2	12	12RM		3		1	4	30	108	Load					Load				
												Reps					Reps				
Total		16		184					21		12										

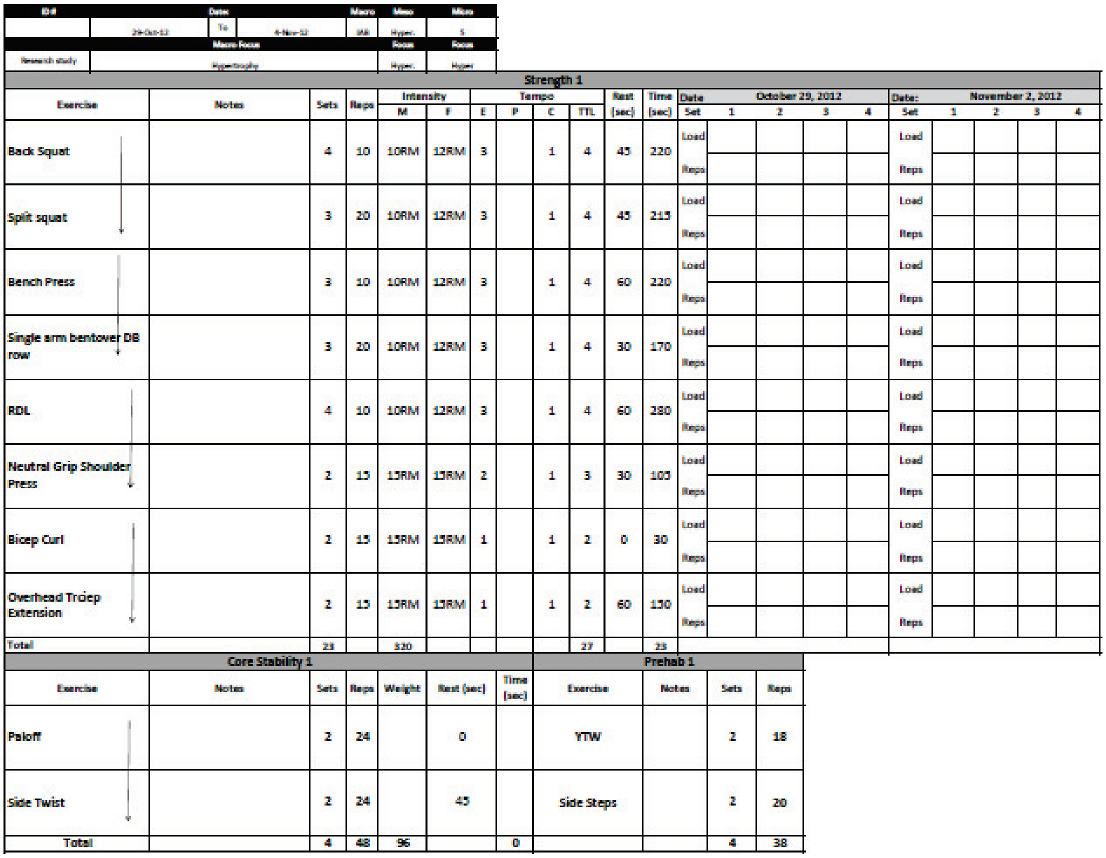
Core Stability 2

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Bridge Sequence	hold for 15 sec each position	2	4	x	0	
Jackknife		2	15	x	45	
Total		4	19	38		0

Prehab 2

Exercise	Notes	Sets	Reps
YTW		2	18
Side Steps		2	20
		4	38

Week 5



ID#	Date			Macro	Meso	Micro
	29-Oct-12	To	4-Nov-12	[illegible]	Hyper.	5
	Macro Focus				Focus	Focus
Research study	Hypertrophy				Hyper.	Hyper

Strength 1

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest	Time	Date	October 29, 2012				Date:	November 2, 2012			
				M	F	E	P	C	TTL	(sec)	(sec)	Set	1	2	3	4	Set	1	2	3	4
Back Squat		4	10	10RM	12RM	3		1	4	45	220	Load					Load				
												Reps					Reps				
Split squat		3	20	10RM	12RM	3		1	4	45	215	Load					Load				
												Reps					Reps				
Bench Press		3	10	10RM	12RM	3		1	4	60	220	Load					Load				
												Reps					Reps				
Single arm bentover DB row		3	20	10RM	12RM	3		1	4	30	170	Load					Load				
												Reps					Reps				
RDL		4	10	10RM	12RM	3		1	4	60	280	Load					Load				
												Reps					Reps				
Neutral Grip Shoulder Press		2	15	15RM	15RM	2		1	3	30	105	Load					Load				
												Reps					Reps				
Bicep Curl		2	15	15RM	15RM	1		1	2	0	30	Load					Load				
												Reps					Reps				
Overhead Tricep Extension		2	15	15RM	15RM	1		1	2	60	150	Load					Load				
												Reps					Reps				
Total		23		320					27		23										

Core Stability 1

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Paloff		2	24		0	
Side Twist		2	24		45	
Total		4	48	96		0

Prehab 1

Exercise	Notes	Sets	Reps
YTW		2	18
Side Steps		2	20
		4	38

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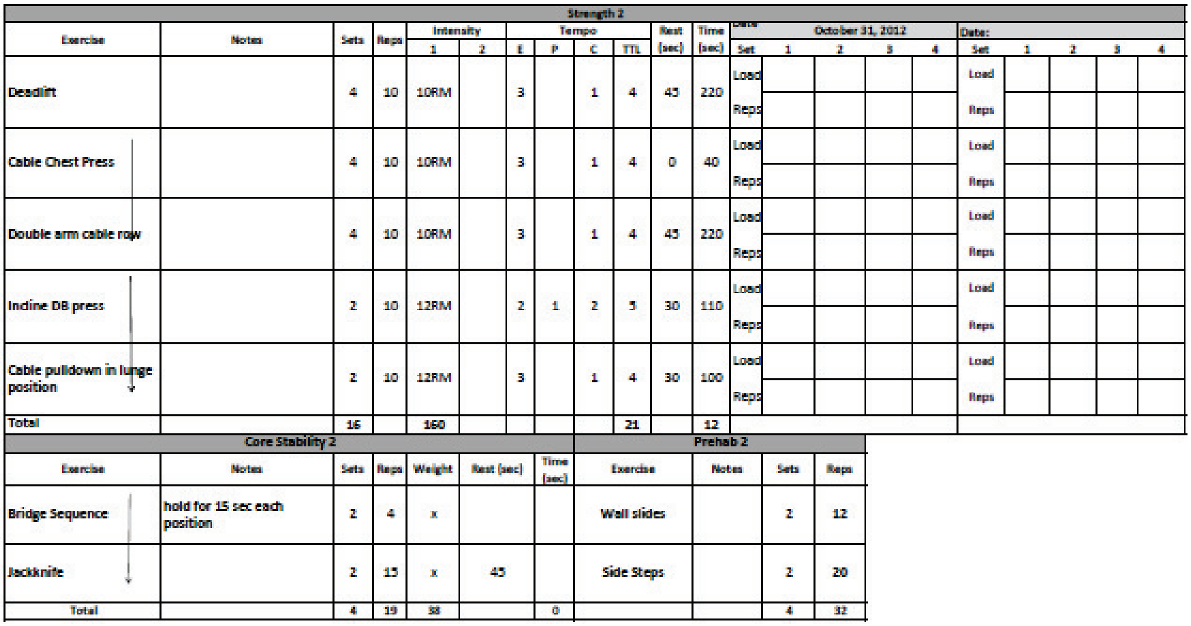


Strength 2

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date	October 31, 2012				Date:			
				1	2	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Deadlift		4	10	10RM		3		1	4	45	220	Load					Load				
												Reps					Reps				
Cable Chest Press		4	10	10RM		3		1	4	0	40	Load					Load				
												Reps					Reps				
Double arm cable row		4	10	10RM		3		1	4	45	220	Load					Load				
												Reps					Reps				
Incline DB press		2	10	12RM		2	1	2	5	30	110	Load					Load				
												Reps					Reps				
Cable pulldown in lunge position		2	10	12RM		3		1	4	30	100	Load					Load				
												Reps					Reps				
Total		16		160					21		12										

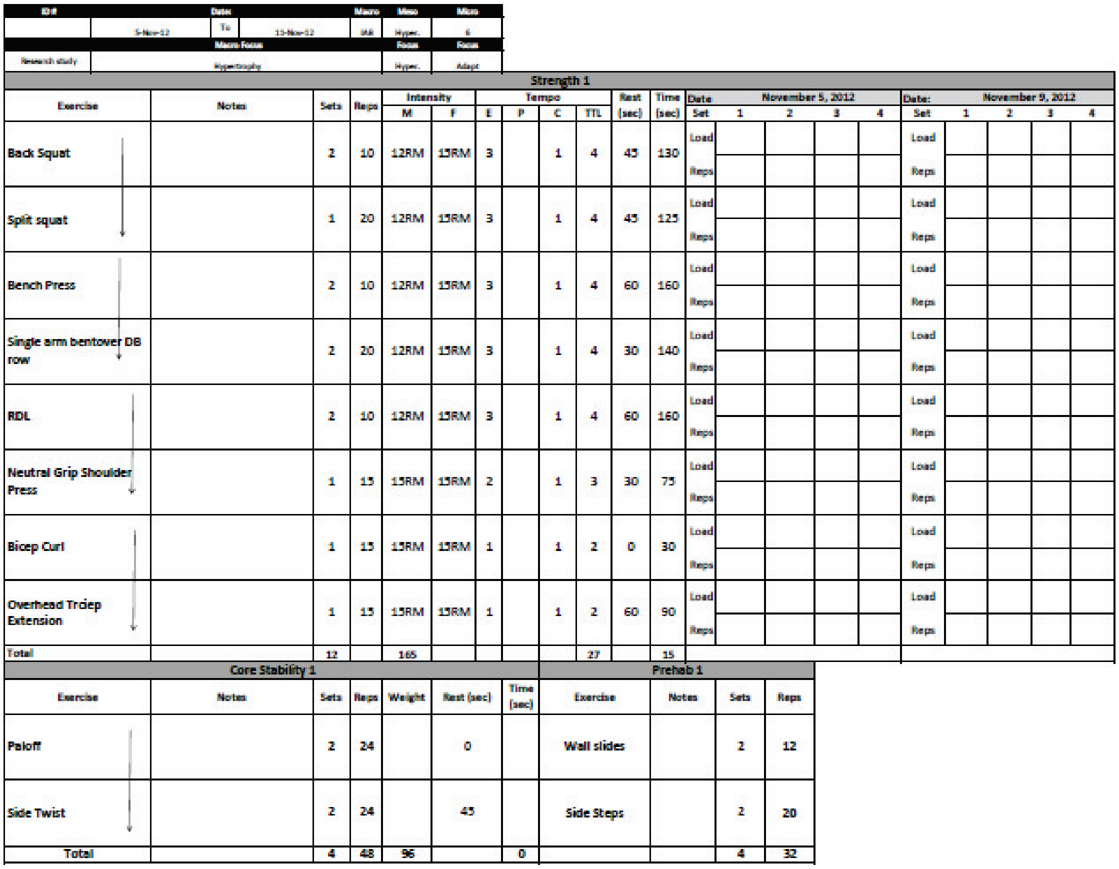
Core Stability 2

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Bridge Sequence	hold for 15 sec each position	2	4	x		
Jackknife		2	15	x	45	
Total		4	19	38		0

Prehab 2

Exercise	Notes	Sets	Reps
Wall slides		2	12
Side Steps		2	20
		4	32

Week 6



ID#	Date			Macro	Meso	Micro
	5-Nov-12	To	11-Nov-12	IAR	Hyper.	6
	Macro Focus				Focus	Focus
Research study	Hypertrophy				Hyper.	Adapt

Strength 1

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date	November 5, 2012				Date:	November 9, 2012			
				M	F	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Back Squat		2	10	12RM	15RM	3		1	4	45	130	Load					Load				
												Reps					Reps				
Split squat		1	20	12RM	15RM	3		1	4	45	125	Load					Load				
												Reps					Reps				
Bench Press		2	10	12RM	15RM	3		1	4	60	160	Load					Load				
												Reps					Reps				
Single arm bentover DB row		2	20	12RM	15RM	3		1	4	30	140	Load					Load				
												Reps					Reps				
RDL		2	10	12RM	15RM	3		1	4	60	160	Load					Load				
												Reps					Reps				
Neutral Grip Shoulder Press		1	15	15RM	15RM	2		1	3	30	75	Load					Load				
												Reps					Reps				
Bicep Curl		1	15	15RM	15RM	1		1	2	0	30	Load					Load				
												Reps					Reps				
Overhead Trciep Extension		1	15	15RM	15RM	1		1	2	60	90	Load					Load				
												Reps					Reps				
Total		12		165					27		15										

Core Stability 1

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Paloff		2	24		0	
Side Twist		2	24		45	
Total		4	48	96		0

Prehab 1

Exercise	Notes	Sets	Reps
Wall slides		2	12
Side Steps		2	20
		4	32

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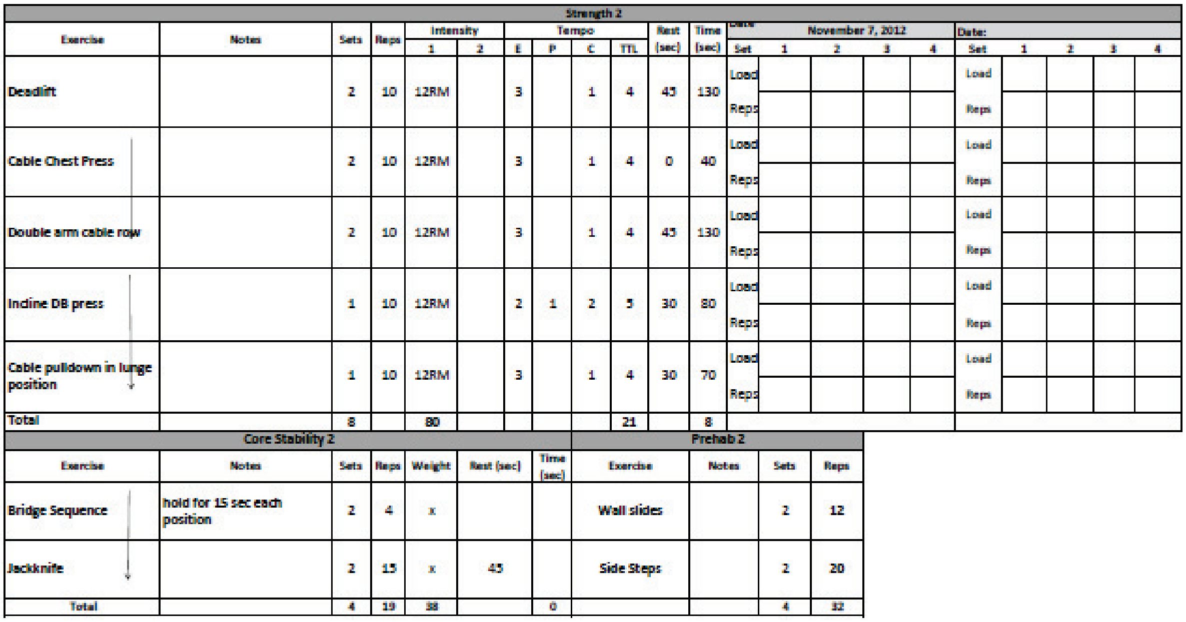


Strength 2

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)		November 7, 2012				Date:			
				1	2	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Deadlift		2	10	12RM		3		1	4	45	130	Load					Load				
												Reps					Reps				
Cable Chest Press		2	10	12RM		3		1	4	0	40	Load					Load				
												Reps					Reps				
Double arm cable row		2	10	12RM		3		1	4	45	130	Load					Load				
												Reps					Reps				
Incline DB press		1	10	12RM		2	1	2	5	30	80	Load					Load				
												Reps					Reps				
Cable pulldown in lunge position		1	10	12RM		3		1	4	30	70	Load					Load				
												Reps					Reps				
Total		8		80					21		8										

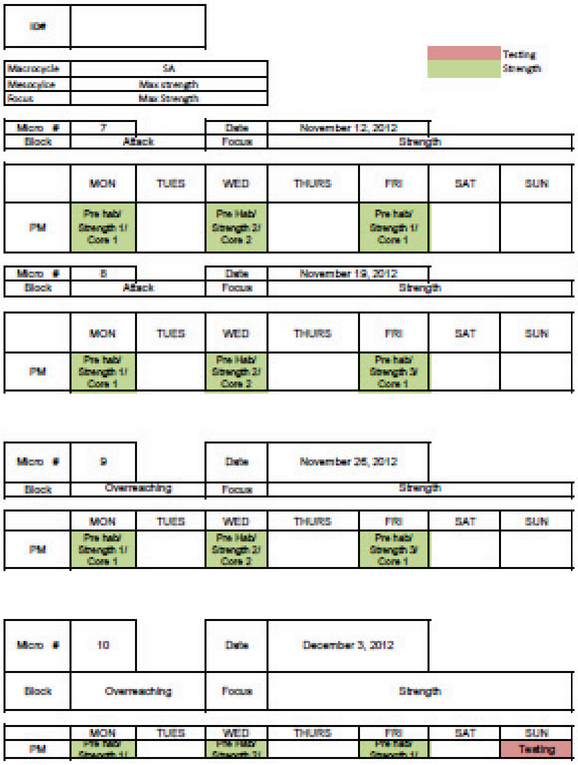
Core Stability 2

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Bridge Sequence	hold for 15 sec each position	2	4	x		
Jackknife		2	15	x	45	
Total		4	19	38		0

Prehab 2

Exercise	Notes	Sets	Reps
Wall slides		2	12
Side Steps		2	20
		4	32

STRENGTH TRAINING PHASE OVERVIEW (WEEKS 7-10)



ID#	

🟥 Testing
🟩 Strength

Macrocycle	SA
Mesocylce	Max strength
Focus	Max Strength

Micro #	7	Date	November 12, 2012
Block	Attack	Focus	Strength

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Pre hab/ Strength 1/ Core 1		Pre Hab/ Strength 2/ Core 2		Pre hab/ Strength 1/ Core 1		

Micro #	8	Date	November 19, 2012
Block	Attack	Focus	Strength

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Pre hab/ Strength 1/ Core 1		Pre Hab/ Strength 2/ Core 2		Pre hab/ Strength 3/ Core 1		

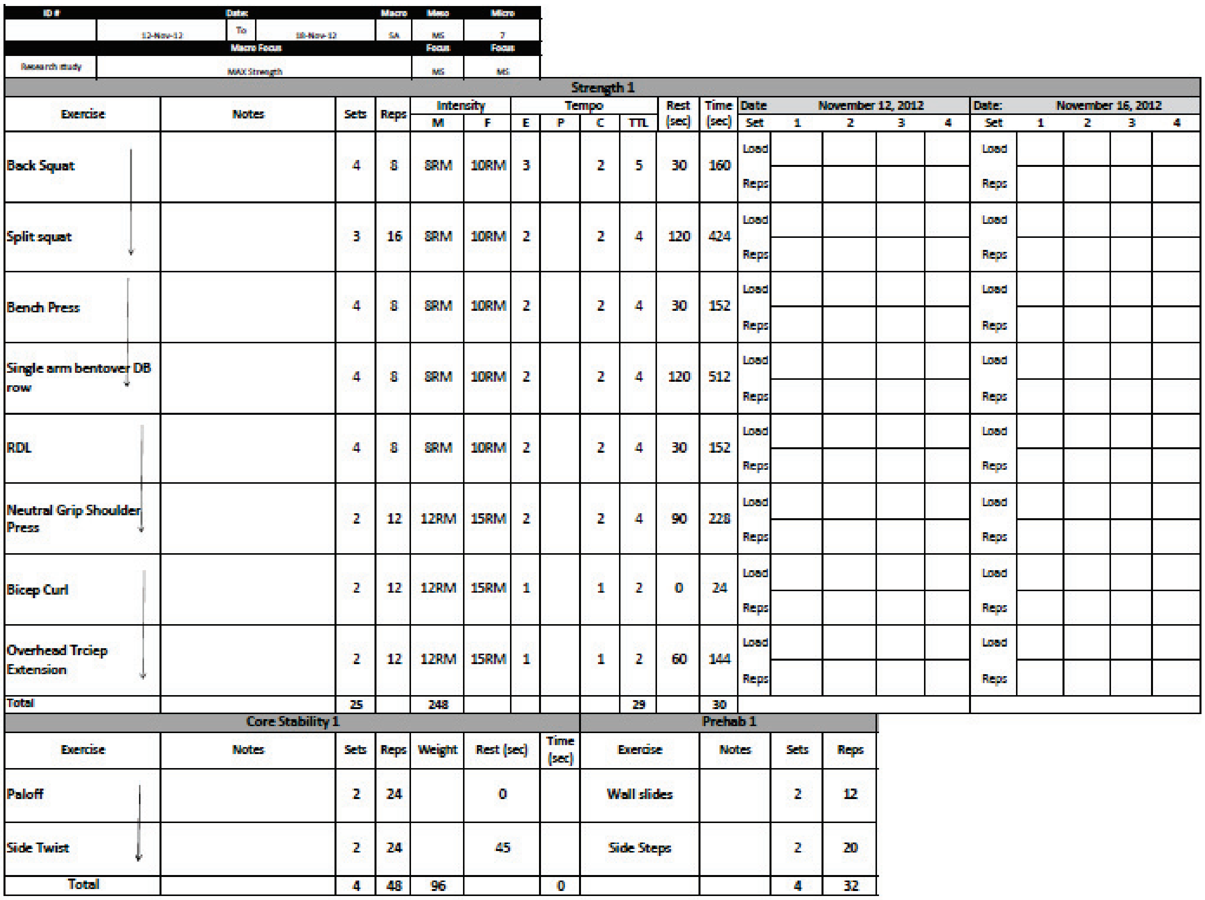
Micro #	9	Date	November 26, 2012
Block	Overreaching	Focus	Strength

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Pre hab/ Strength 1/ Core 1		Pre Hab/ Strength 2/ Core 2		Pre hab/ Strength 3/ Core 1		

Micro #	10	Date	December 3, 2012
Block	Overreaching	Focus	Strength

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Pre hab/ Strength 1/		Pre Hab/ Strength 2/		Pre hab/ Strength 1/		Testing

Week 7



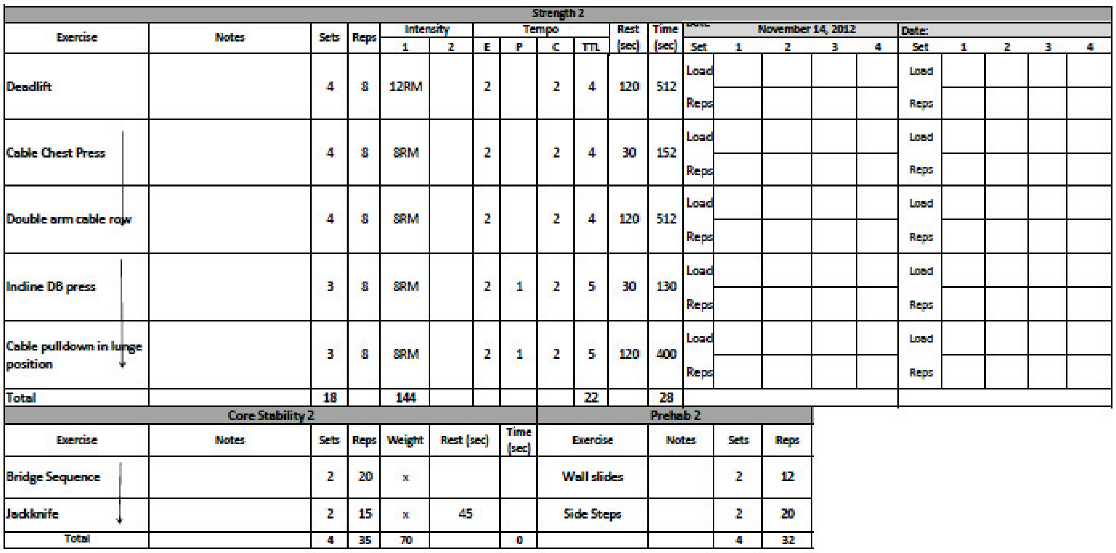
ID #	Date:			Macro	Meso	Micro
	12-Nov-12	To	18-Nov-12	SA	MS	7
	Macro Focus				Focus	Focus
Research study	MAX Strength				MS	MS

Strength 1

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date	November 12, 2012				Date:	November 16, 2012			
				M	F	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Back Squat		4	8	8RM	10RM	3		2	5	30	160	Load					Load				
												Reps					Reps				
Split squat		3	16	8RM	10RM	2		2	4	120	424	Load					Load				
												Reps					Reps				
Bench Press		4	8	8RM	10RM	2		2	4	30	152	Load					Load				
												Reps					Reps				
Single arm bentover DB row		4	8	8RM	10RM	2		2	4	120	512	Load					Load				
												Reps					Reps				
RDL		4	8	8RM	10RM	2		2	4	30	152	Load					Load				
												Reps					Reps				
Neutral Grip Shoulder Press		2	12	12RM	15RM	2		2	4	90	228	Load					Load				
												Reps					Reps				
Bicep Curl		2	12	12RM	15RM	1		1	2	0	24	Load					Load				
												Reps					Reps				
Overhead Trciep Extension		2	12	12RM	15RM	1		1	2	60	144	Load					Load				
												Reps					Reps				
Total		25		248					29		30										

Core Stability 1							Prehab 1			
Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)	Exercise	Notes	Sets	Reps
Paloff		2	24		0		Wall slides		2	12
Side Twist		2	24		45		Side Steps		2	20
Total		4	48	96		0			4	32

Produced By: Jesse Adams BKin, COKA, CSCS



Strength 2

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	November 14, 2012					Date:				
				1	2	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Deadlift		4	8	12RM		2		2	4	120	512	Load					Load				
												Reps					Reps				
Cable Chest Press		4	8	8RM		2		2	4	30	152	Load					Load				
												Reps					Reps				
Double arm cable row		4	8	8RM		2		2	4	120	512	Load					Load				
												Reps					Reps				
Incline DB press		3	8	8RM		2	1	2	5	30	130	Load					Load				
												Reps					Reps				
Cable pulldown in lunge position		3	8	8RM		2	1	2	5	120	400	Load					Load				
												Reps					Reps				
Total		18		144					22		28										

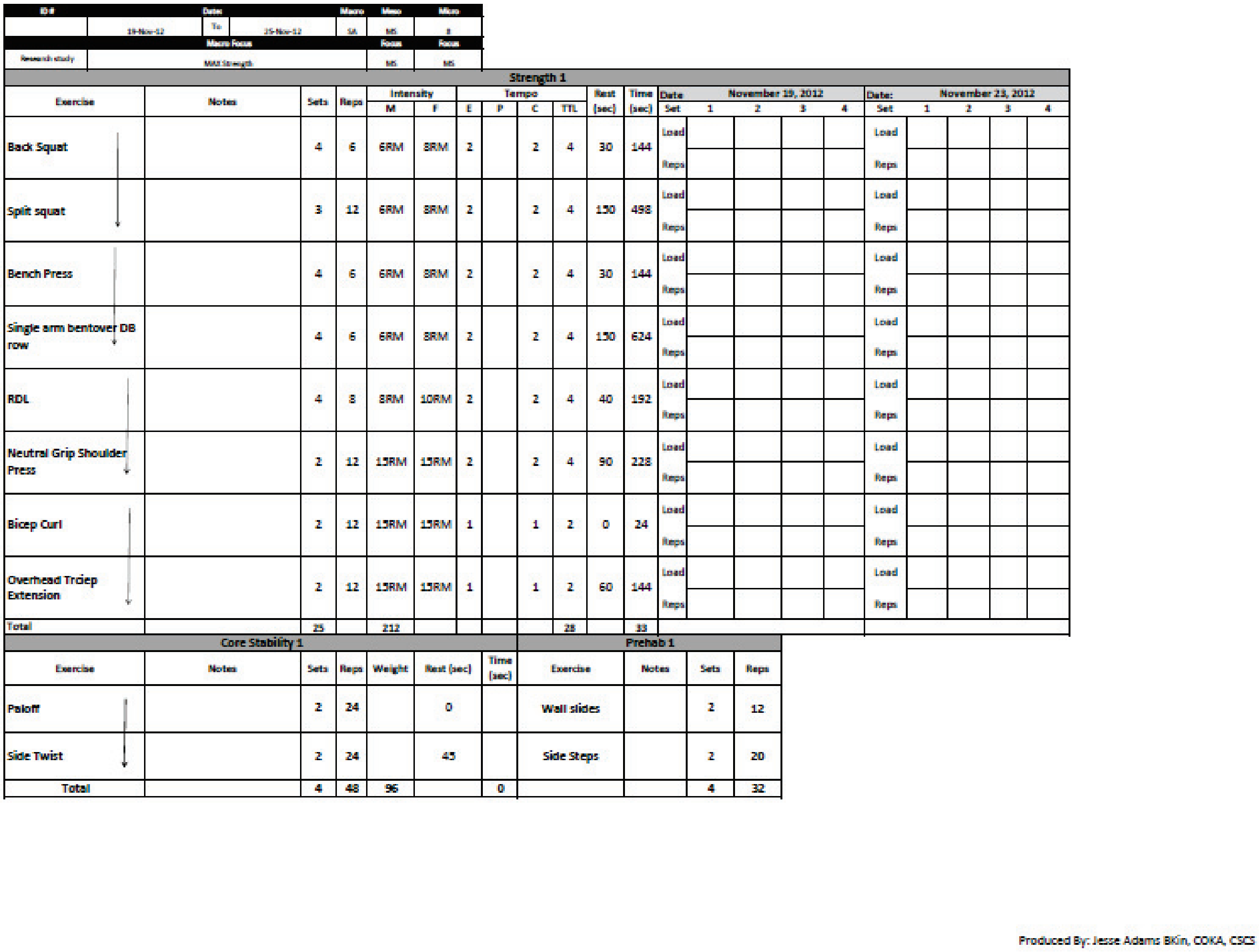
Core Stability 2

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Bridge Sequence		2	20	x		
Jackknife		2	15	x	45	
Total		4	35	70		0

Prehab 2

Exercise	Notes	Sets	Reps
Wall slides		2	12
Side Steps		2	20
		4	32

Week 8



ID #	Date:			Macro	Meso	Micro
	19-Nov-12	To	25-Nov-12	SA	MS	8
	Macro Focus				Focus	Focus
Research study	MAX Strength				MS	MS

Strength 1

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest	Time	Date	November 19, 2012				Date:	November 23, 2012			
				M	F	E	P	C	TTL	(sec)	(sec)	Set	1	2	3	4	Set	1	2	3	4
Back Squat		4	6	6RM	8RM	2		2	4	30	144	Load					Load				
												Reps					Reps				
Split squat		3	12	6RM	8RM	2		2	4	150	498	Load					Load				
												Reps					Reps				
Bench Press		4	6	6RM	8RM	2		2	4	30	144	Load					Load				
												Reps					Reps				
Single arm bentover DB row		4	6	6RM	8RM	2		2	4	150	624	Load					Load				
												Reps					Reps				
RDL		4	8	8RM	10RM	2		2	4	40	192	Load					Load				
												Reps					Reps				
Neutral Grip Shoulder Press		2	12	15RM	15RM	2		2	4	90	228	Load					Load				
												Reps					Reps				
Bicep Curl		2	12	15RM	15RM	1		1	2	0	24	Load					Load				
												Reps					Reps				
Overhead Triep Extension		2	12	15RM	15RM	1		1	2	60	144	Load					Load				
												Reps					Reps				
Total		25		212					28		33										

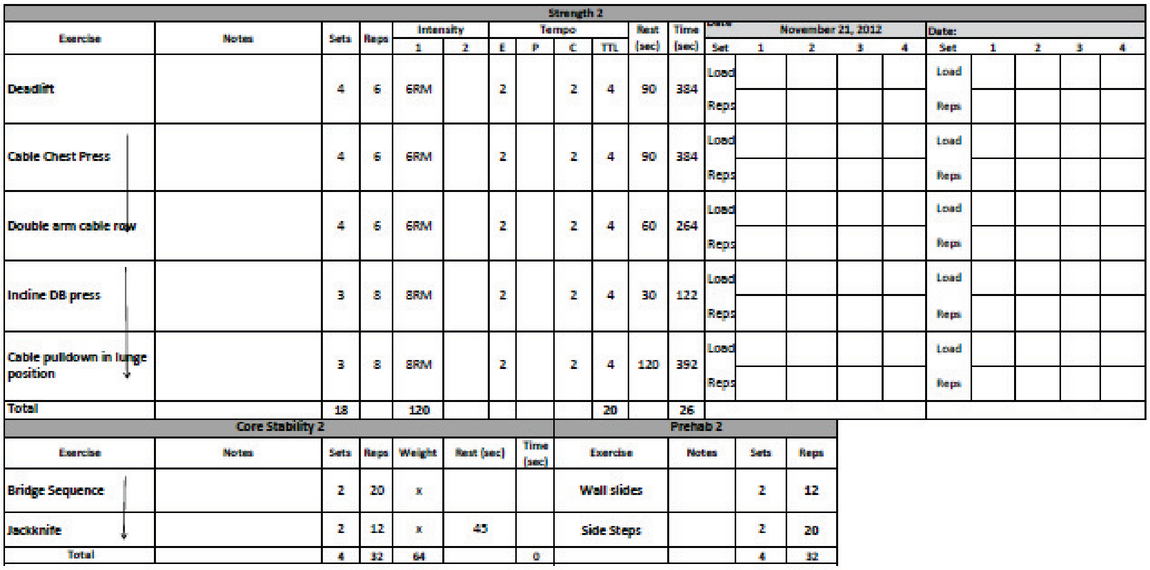
Core Stability 1

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Paloff		2	24		0	
Side Twist		2	24		45	
Total		4	48	96		0

Prehab 1

Exercise	Notes	Sets	Reps
Wall slides		2	12
Side Steps		2	20
		4	32

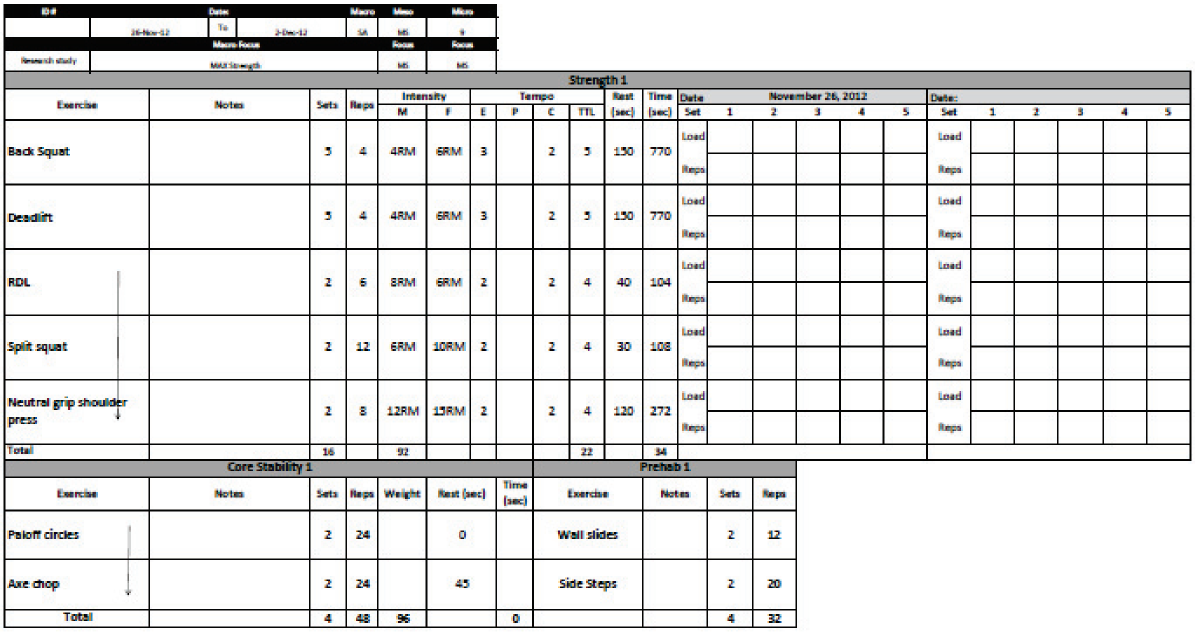
Produced By: Jesse Adams BKin, CCKA, CSCS



Strength 2																					
Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date	November 21, 2012				Date:				
				1	2	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Deadlift		4	6	6RM		2		2	4	90	384	Load					Load				
												Reps					Reps				
Cable Chest Press		4	6	6RM		2		2	4	90	384	Load					Load				
												Reps					Reps				
Double arm cable row		4	6	6RM		2		2	4	60	264	Load					Load				
												Reps					Reps				
Incline DB press		3	8	8RM		2		2	4	30	122	Load					Load				
												Reps					Reps				
Cable pulldown in lunge position		3	8	8RM		2		2	4	120	392	Load					Load				
												Reps					Reps				
Total		18		120					20		26										

Core Stability 2							Prehab 2			
Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)	Exercise	Notes	Sets	Reps
Bridge Sequence		2	20	x			Wall slides		2	12
Jackknife		2	12	x	45		Side Steps		2	20
Total		4	32	64		0			4	32

Week 9



ID#	Date			Macro	Meso	Micro
	26-Nov-12	To	2-Dec-12	SA	MS	9
	Macro Focus				Focus	Focus
Research study	MAX Strength				MS	MS

Strength 1

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest	Time	Date	November 26, 2012					Date:					
				M	F	E	P	C	TTL	(sec)	(sec)	Set	1	2	3	4	5	Set	1	2	3	4	5
Back Squat		5	4	4RM	6RM	3		2	5	150	770	Load						Load					
												Reps						Reps					
Deadlift		5	4	4RM	6RM	3		2	5	150	770	Load						Load					
												Reps						Reps					
RDL		2	6	8RM	6RM	2		2	4	40	104	Load						Load					
												Reps						Reps					
Split squat		2	12	6RM	10RM	2		2	4	30	108	Load						Load					
												Reps						Reps					
Neutral grip shoulder press		2	8	12RM	15RM	2		2	4	120	272	Load						Load					
												Reps						Reps					
Total		16		92					22		34												

Core Stability 1

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Paloff circles		2	24		0	
Axe chop		2	24		45	
Total		4	48	96		0

Prehab 1

Exercise	Notes	Sets	Reps
Wall slides		2	12
Side Steps		2	20
		4	32

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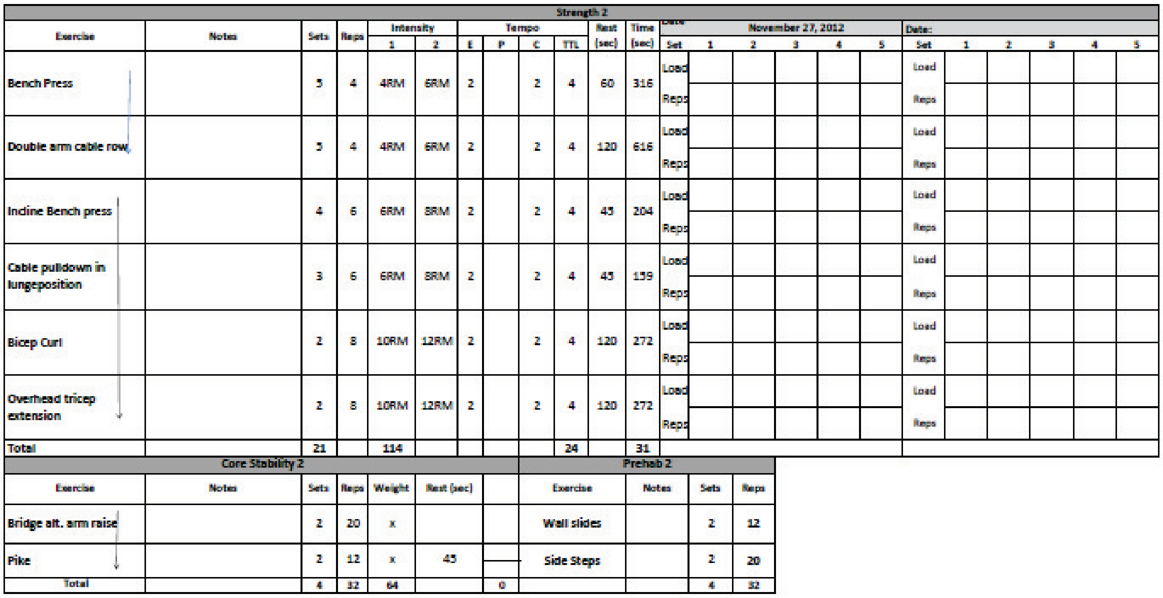


Strength 2

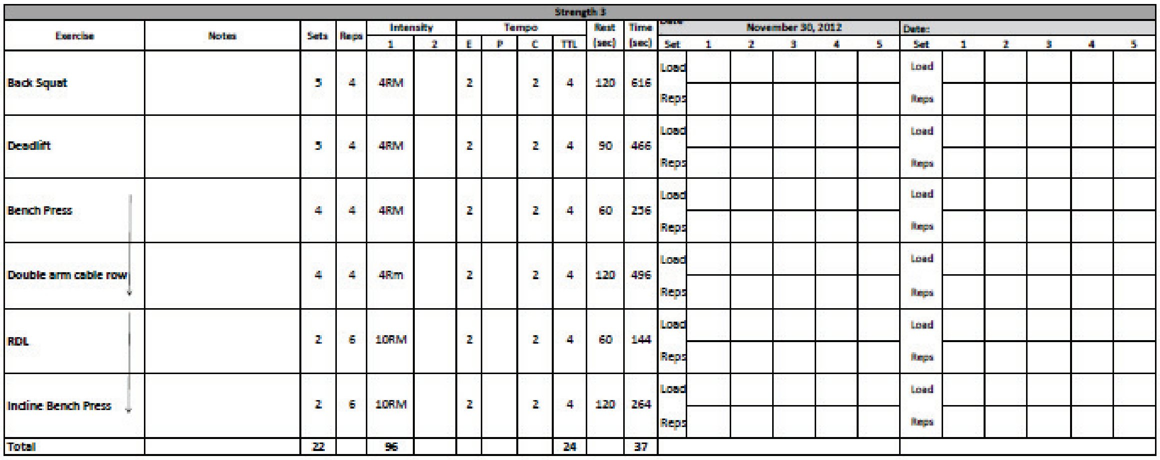
Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)		November 27, 2012					Date:					
				1	2	E	P	C	TTL			Set	1	2	3	4	5	Set	1	2	3	4	5
Bench Press		5	4	4RM	6RM	2		2	4	60	316	Load						Load					
												Reps						Reps					
Double arm cable row		5	4	4RM	6RM	2		2	4	120	616	Load						Load					
												Reps						Reps					
Incline Bench press		4	6	6RM	8RM	2		2	4	45	204	Load						Load					
												Reps						Reps					
Cable pulldown in lungeposition		3	6	6RM	8RM	2		2	4	45	159	Load						Load					
												Reps						Reps					
Bicep Curl		2	8	10RM	12RM	2		2	4	120	272	Load						Load					
												Reps						Reps					
Overhead tricep extension		2	8	10RM	12RM	2		2	4	120	272	Load						Load					
												Reps						Reps					
Total		21		114					24		31												

Core Stability 2

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	
Bridge alt. arm raise		2	20	x		
Pike		2	12	x	45	
Total		4	32	64		0

Prehab 2

Exercise	Notes	Sets	Reps
Wall slides		2	12
Side Steps		2	20
		4	32



Strength 3

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date	November 30, 2012					Date:					
				1	2	E	P	C	TTL			Set	1	2	3	4	5	Set	1	2	3	4	5
Back Squat		5	4	4RM		2		2	4	120	616	Load						Load					
												Reps						Reps					
Deadlift		5	4	4RM		2		2	4	90	466	Load						Load					
												Reps						Reps					
Bench Press		4	4	4RM		2		2	4	60	256	Load						Load					
												Reps						Reps					
Double arm cable row		4	4	4Rm		2		2	4	120	496	Load						Load					
												Reps						Reps					
RDL		2	6	10RM		2		2	4	60	144	Load						Load					
												Reps						Reps					
Incline Bench Press		2	6	10RM		2		2	4	120	264	Load						Load					
												Reps						Reps					
Total		22		96					24		37												

Week 10

ID#	Date:			Macro	Meso	Micro
	3-Dec-12	To	9-Dec-12	1A	MS	10
	Macro Focus				Focus	Focus
Research study	MAX Strength				MS	MS

Strength 1

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest	Time	Date			December 3, 2012			Date:			December 6, 2012		
				M	F	E	P	C	TTL	(sec)	(sec)	Set	1	2	3	4	5	Set	1	2	3	4	5
Back Squat		5	4	4RM	6RM	3		2	5	150	770	Load						Load					
												Reps						Reps					
Deadlift		5	4	4RM	6RM	3		2	5	150	770	Load						Load					
												Reps						Reps					
RDL		2	6	8RM	6RM	2		2	4	90	204	Load						Load					
												Reps						Reps					
Split squat		2	12	6RM	10RM	2		2	4	45	138	Load						Load					
												Reps						Reps					
Neutral grip shoulder press		2	8	12RM	15RM	2		2	4	120	272	Load						Load					
												Reps						Reps					
Total		16		92					22		36												

Core Stability 1

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Paloff circles		2	24		0	
Axe chop		2	24		45	
Total		4	48	96		0

Prehab 1

Exercise	Notes	Sets	Reps
Wall slides		2	12
Side Steps		2	20
		4	32

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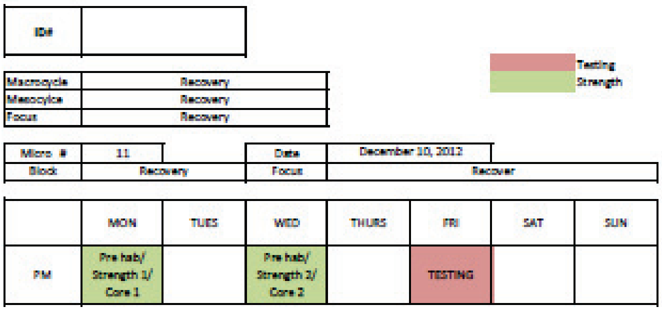
Strength 2																							
Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)		December 4, 2012					Date:	December 7, 2012				
				1	2	E	P	C	TTL			Set	1	2	3	4	5	Set	1	2	3	4	5
Bench Press		5	4	4RM	6RM	2		2	4	60	316	Load						Load					
												Reps						Reps					
Double arm cable row		5	4	4RM	6RM	2		2	4	120	616	Load						Load					
												Reps						Reps					
Incline Bench press		4	6	6RM	8RM	2		2	4	60	264	Load						Load					
												Reps						Reps					
Cable pulldown in lunge position		3	6	6RM	8RM	2		2	4	30	114	Load						Load					
												Reps						Reps					
Bicep Curl		2	8	10RM	12RM	2		2	4	30	92	Load						Load					
												Reps						Reps					
Overhead tricep extension		2	8	10RM	12RM	2		2	4	120	272	Load						Load					
												Reps						Reps					
Total		21		114					24		28												

Core Stability 2							Prehab 2			
Exercise	Notes	Sets	Reps	Weight	Rest (sec)		Exercise	Notes	Sets	Reps
Bridge alt. arm raise		2	20	x			Wall slides		2	12
Pike		2	12	x	45		Side Steps		2	20
Total		4	32	64		0			4	32

Strength 3																							
Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date December 7, 2012						Date:					
				1	2	E	P	C	TTL			Set	1	2	3	4	5	Set	1	2	3	4	5
Back Squat		4	4	4RM		2		2	4	120	496	Load						Load					
												Reps						Reps					
Deadlift		4	4	4RM		2		2	4	90	376	Load						Load					
												Reps						Reps					
Bench Press		4	4	4RM		2		2	4	60	256	Load						Load					
												Reps						Reps					
Double arm cable row		4	4	4Rm		2		2	4	120	496	Load						Load					
												Reps						Reps					
RDL		2	6	10RM		2		2	4	60	144	Load						Load					
												Reps						Reps					
Incline Bench Press		2	6	10RM		2		2	4	120	264	Load						Load					
												Reps						Reps					
Total		20		88					24		34												

TAPER TRAINING PHASE OVERVIEW



ID#	

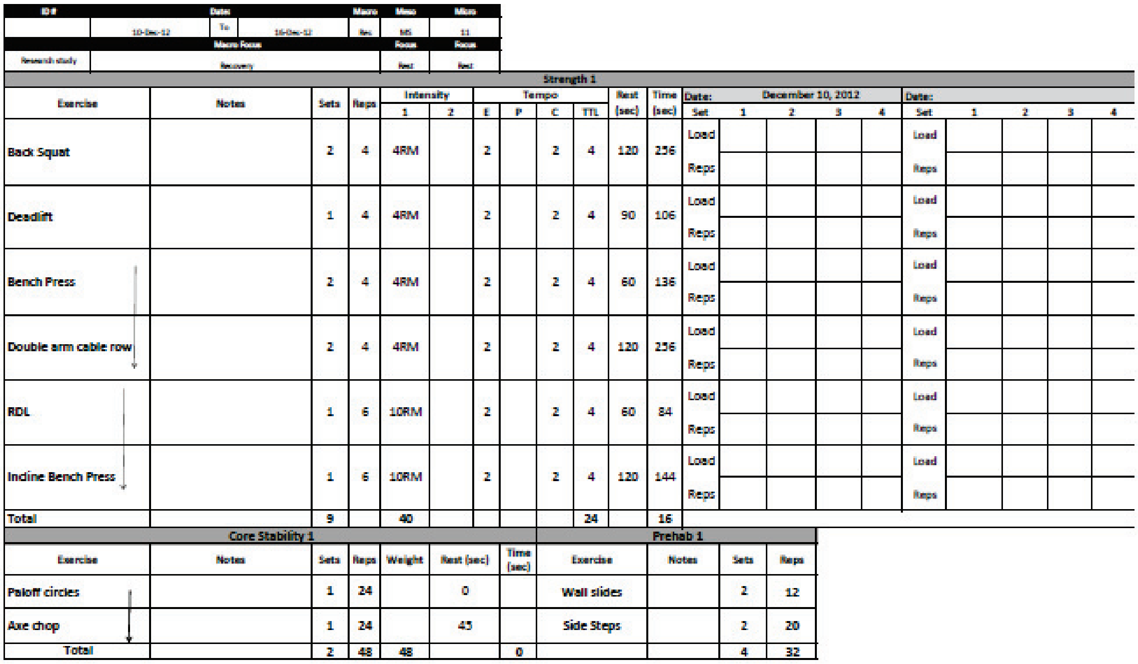
🟥 Testing
🟩 Strength

Macrocycle	Recovery
Mesocyclce	Recovery
Focus	Recovery

Micro #	11	Date	December 10, 2012
Block	Recovery	Focus	Recover

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Pre hab/ Strength 1/ Core 1		Pre hab/ Strength 2/ Core 2		TESTING		

Week 11

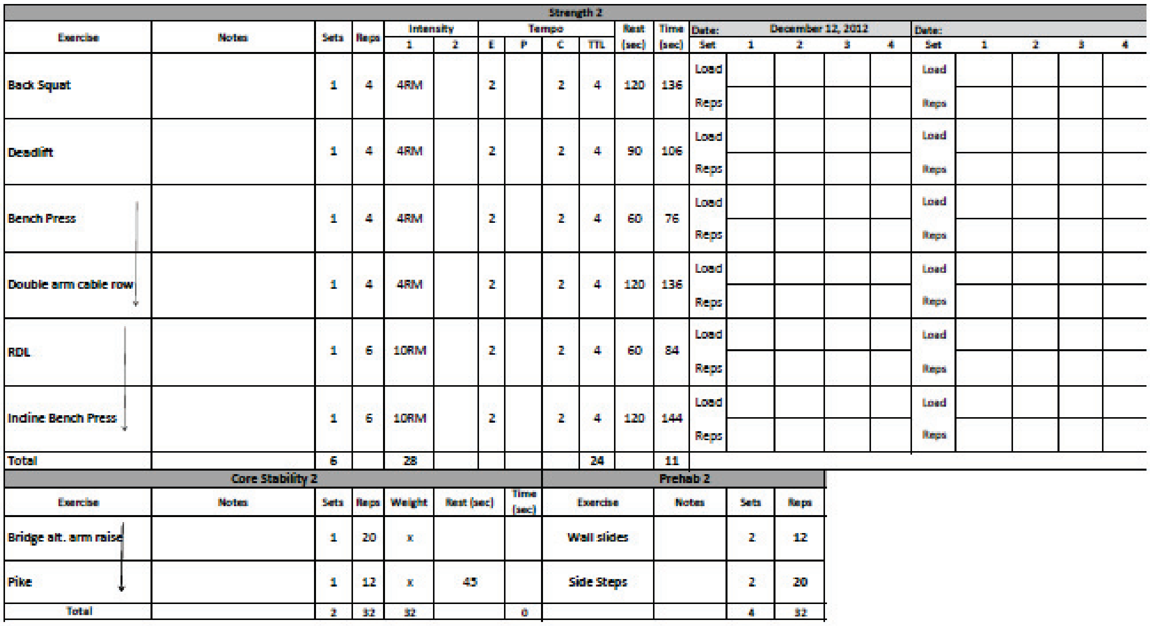


ID #	Dates			Macro	Meso	Micro
	10-Dec-12	To	16-Dec-12	Res	MS	11
	Macro Focus				Focus	Focus
Research study	Recovery				Rest	Rest

Strength 1

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date:	December 10, 2012				Date:				
				1	2	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Back Squat		2	4	4RM		2		2	4	120	256	Load					Load				
												Reps					Reps				
Deadlift		1	4	4RM		2		2	4	90	106	Load					Load				
												Reps					Reps				
Bench Press		2	4	4RM		2		2	4	60	136	Load					Load				
												Reps					Reps				
Double arm cable row		2	4	4RM		2		2	4	120	256	Load					Load				
												Reps					Reps				
RDL		1	6	10RM		2		2	4	60	84	Load					Load				
												Reps					Reps				
Incline Bench Press		1	6	10RM		2		2	4	120	144	Load					Load				
												Reps					Reps				
Total		9		40					24		16										

Core Stability 1							Prehab 1			
Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)	Exercise	Notes	Sets	Reps
Paloff circles		1	24		0		Wall slides		2	12
Axe chop		1	24		45		Side Steps		2	20
Total		2	48	48		0			4	32



Strength 2

Exercise	Notes	Sets	Reps	Intensity		Tempo				Rest (sec)	Time (sec)	Date:	December 12, 2012				Date:				
				1	2	E	P	C	TTL			Set	1	2	3	4	Set	1	2	3	4
Back Squat		1	4	4RM		2		2	4	120	136	Load					Load				
												Reps					Reps				
Deadlift		1	4	4RM		2		2	4	90	106	Load					Load				
												Reps					Reps				
Bench Press		1	4	4RM		2		2	4	60	76	Load					Load				
												Reps					Reps				
Double arm cable row		1	4	4RM		2		2	4	120	136	Load					Load				
												Reps					Reps				
RDL		1	6	10RM		2		2	4	60	84	Load					Load				
												Reps					Reps				
Incline Bench Press		1	6	10RM		2		2	4	120	144	Load					Load				
												Reps					Reps				
Total		6		28					24		11										

Core Stability 2

Exercise	Notes	Sets	Reps	Weight	Rest (sec)	Time (sec)
Bridge alt. arm raise		1	20	x		
Pike		1	12	x	45	
Total		2	32	32		0

Prehab 2

Exercise	Notes	Sets	Reps
Wall slides		2	12
Side Steps		2	20
		4	32

APPENDIX G

TEST BATTERY

Thesis Testing Battery

Test Date: ____________________ Location: ____________________

Pre-screening

Subject number ____________________ Sport: ____________________

Compeitive Level: ____________________

Par-Q? ☐ Waiver? ☐ MIQ-R ☐
minimum (3.0)

Anthropometrics/ Flexibility

Height (cm) ____________________ **Weight (kg)** ____________________
(nearest 0.5cm) *(nearest 0.1 kg)*

Girths
(nearset 0.1 mm)

Measurement	1	2
Bicep relaxed		
Bicep Flexed		
Chest		
Waist		
Hips		
Thigh		
Calf		

BIA Body fat % ____________________

Lower Body Max strength

Back Squat (lbs)
3RM
Load ____________________ lbs
Reps ____________________
Predicted 1RM ____________________ lbs

Upper Body Max Strength

Bench Press (lbs)
1RM
Load ____________________ lbs
Reps ____________________
Predicted 1RM ____________________ lbs

Please note any injuries or health concerns: ____

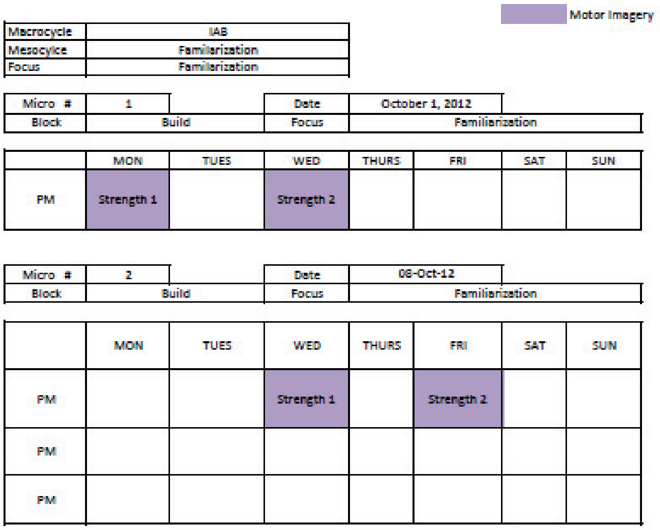
PARTICIPANT TEST SUMMERY TABLE

Name	Test Date	Height	Weight	BMI	Body fat	Girths							1RM Bench press	3RM Back squat
						Bicep F	Bicep R	Chest	Waist	Hips	Thigh	Calf		
		cm	*kg*	*kg/m*^{2}	*%*	*cm*	*cm*	*cm*	*cm*	*cm*	*cm*	*cm*	*kg*	*kg*
Participant x														

APPENDIX H

MOTOR IMAGERY EDUCATIONAL SCHEDULE

Familiarization Training Phase 1-2



🟪 Motor Imagery

Macrocycle	IAB
Mesocylce	Familarization
Focus	Familarization

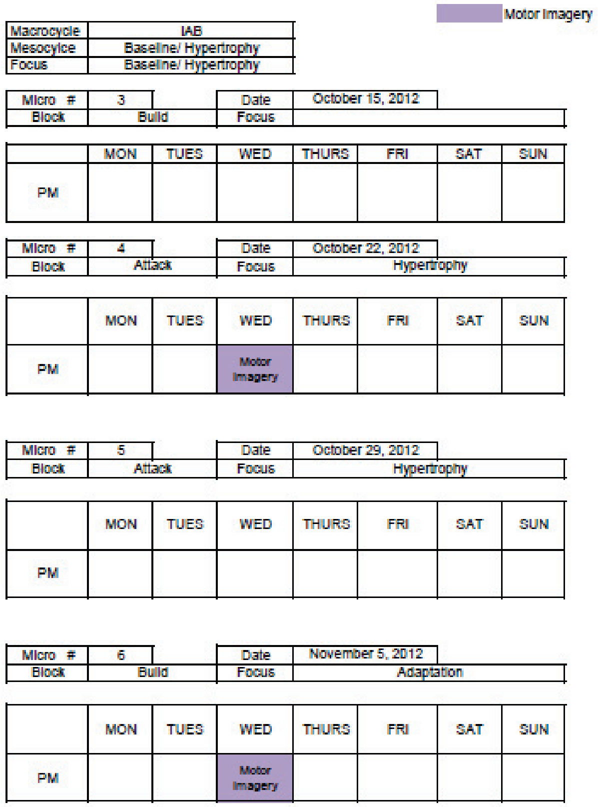
Micro #	1	Date	October 1, 2012
Block	Build	Focus	Familiarization

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM	Strength 1		Strength 2				

Micro #	2	Date	08-Oct-12
Block	Build	Focus	Familiarization

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM			Strength 1		Strength 2		
PM							
PM							

Strength Training Phase 3-6



▨ Motor Imagery

Macrocycle	IAB
Mesocyice	Baseline/ Hypertrophy
Focus	Baseline/ Hypertrophy

Micro #	3	Date	October 15, 2012
Block	Build	Focus	

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM							

Micro #	4	Date	October 22, 2012
Block	Attack	Focus	Hypertrophy

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM			Motor Imagery				

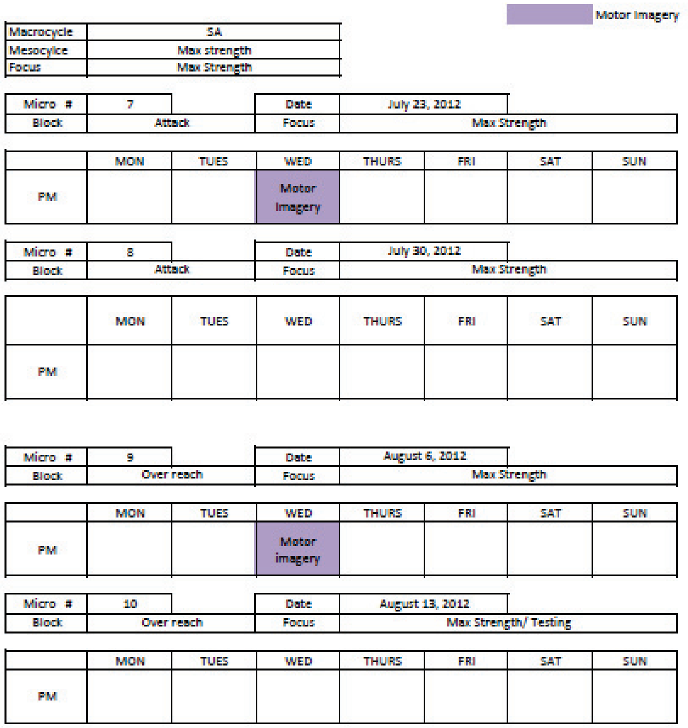
Micro #	5	Date	October 29, 2012
Block	Attack	Focus	Hypertrophy

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM							

Micro #	6	Date	November 5, 2012
Block	Build	Focus	Adaptation

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM			Motor Imagery				

Strength Training Phase 7-10



🟪 Motor Imagery

Macrocycle	SA
Mesocylce	Max strength
Focus	Max Strength

Micro #	7	Date	July 23, 2012
Block	Attack	Focus	Max Strength

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM			Motor Imagery				

Micro #	8	Date	July 30, 2012
Block	Attack	Focus	Max Strength

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM							

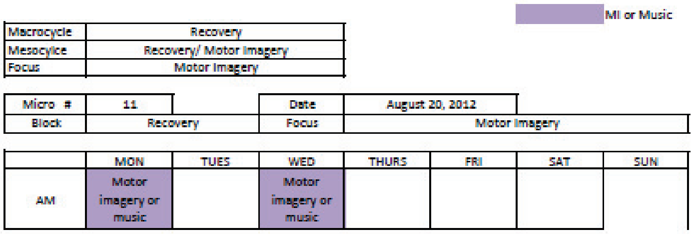
Micro #	9	Date	August 6, 2012
Block	Over reach	Focus	Max Strength

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM			Motor imagery				

Micro #	10	Date	August 13, 2012
Block	Over reach	Focus	Max Strength/ Testing

	MON	TUES	WED	THURS	FRI	SAT	SUN
PM							

Taper Training Phase 11



▨ MI or Music

Macrocycle	Recovery
Mesocyice	Recovery/ Motor Imagery
Focus	Motor Imagery

Micro #	11		Date	August 20, 2012
Block	Recovery		Focus	Motor Imagery

	MON	TUES	WED	THURS	FRI	SAT	SUN
AM	Motor imagery or music		Motor imagery or music				

MOTOR IMAGERY EDUCATIONAL SESSION TEMPLATE

Motor Imagery Script

OUTLINE:

- Physical
  - The participant will be standing or lying on bench to mimic body position of exercises being imaged
- Environmental
  - Motor imagery will be done within Sport enter
- Task
  - The participant will image each exercise (i.e. squat, deadlift)
- Timing
  - The motor imagery session will last 30 to 40 minutes (same tempo, rest and sets as workout)
  - Each motor imagery rep will have the same tempo as the physical rep follow the
- Emotion
  - The participant may listen to their own music at a volume they can still hear the guided imagery
  - The participant does not need to be in an aroused state want to mimic emotions
- Perspective
  - During the motor imagery sessions a kinesthetic perspective video of each exercise sequence will be played
  - The participant will be "cued" to visualize themselves in a kinesthetic perspective not third person however if the participant has to they can use third person perspective

STRENGTH 1:

Step into the Weight Room to Begin Strength 1

- See all the weights, benches and racks
- Feel the rubber floor under your feet
- Smell the weight room: the sweat, metal and rubber
- Listen to the sound of weights dropping, the music you listen to when you workout

Back Squat

1. Picture yourself standing in front of the rack
    - See the bar in front of you
    - See your hands grab the bar
    - See the weight you use on the end of the bar (i.e. 200 lbs)
    - Feel the bumps on the bar and the hard metal
    - Feel your adrenaline increase as you want to lift this heavy weight
2. Step up to and under the bar
    - Feel the weight and hardness of the bar as it rests on your shoulders placing it on your shoulders
3. Lift the bar off the rack
    - Feel the weight of the bar pushing into your shoulders
4. Step back and get set
5. Begin to lower for your first rep
    - Feel your gluteus and hamstring eccentrically contracting fighting against the weight
    - Feel your knees lowering gets\ting closer to 90
    - See yourself in the mirror to make sure you're getting all the way down
    - Feel the air entering your lungs as you inhale
    - *** should take 3 sec for eccentric phase
6. Once your knees are at 90 start to contract your gluteus and quadriceps
    - Feel you knees straightening slowly
    - See you self in the mirror
    - Stop just before your knee locks
    - Feel you diaphragm in full contraction as you exhale with the contraction
    - ****should take 2 second for concentric phase
7. Repeat steps 5 and 6 three more times
8. Once finished step forward placing the bar onto the rack, hear the metal bar hit the metal rack
9. Once racked feel the weight lift off your shoulders
10. Feel the emotions, the fatigue in your muscle after completing a really heavy set

Split Squat

1. Picture yourself standing in front of the dumbbells
    - See them on the ground in front of you
    - See your hands grab the dumbbells
    - See the weight you use on the end of the dumbbell (i.e. 20 lbs)

    - Feel the bumps on the handle and the hard metal
    - Feel your adrenaline increase as you want to lift this heavy weight
2. Stand up straight holding the dumbbell
    - Feel the weight and hardness of the dumbbells in your hands
3. Lift your left leg and put it on the box behind you
    - Bounce around as you get your balance on your one front foot
    - Feel your muscles contracting in your front leg (gluteus hamstrings)
    - Feel your quadriceps and hip flexors stretch in the back leg as you position yourself
4. Begin to lower for your first rep
    - Feel your gluten and hamstring eccentrically contracting fighting against the weight
    - Feel the quadriceps and hip flexors in your back leg stretch as you sink lower in the squat
    - Feel your knee lowering gets\ting closer to 90
    - See yourself in the mirror to make sure you're getting all the way down keeping you knee behind your toes
    - Feel the air entering your lungs as you inhale
    - *** should take 2 sec for eccentric phase
5. Once your knees are at 90 start to contract your gluteus and quadriceps
    - Feel you diaphragm in full contraction as you exhale with the contraction
    - Feel you knee straightening slowly
    - See you self in the mirror
    - Stop just before your knee locks
    - ****should take 2 second for concentric phase
6. Repeat steps 4 and 5 four more times
7. Once finished move your back leg off the box
8. Repeat steps 3 to 6 5 times
9. Once finished drop the dumbbells, feel the weight being removed from your hands, feel the release of tension in your forearms
10. Feel the emotions, the fatigue in your muscle after completing a really heavy set

Bench Press

1. Picture yourself lying on the bench press
    - Feel the pad on the bench you are lying on and the ground under your feet
    - See the bar in above you

   - See your hands grab the bar
   - See the weight you use on the end of the bar (i.e. 200 lbs)
   - Feel the bumps on the bar and the hard metal
   - Feel your adrenaline increase as you want to lift this heavy weight
2. Lift the Barbell of the rack
   - Feel the weight in your hands
   - Feel the air moving in and out of your lungs as you regulate your breathing
3. Begin to lower the Barbell towards your chest
   - over your head
   - Feel your pectorals and triceps eccentrically contracting as the weight is being lowered
   - Feel your elbows begin to bend
   - Feel your abdominals contract as you stabilize your body
   - See the bar coming towards you
   - Feel the air entering your lungs as you control your breathing, inhaling
   - The eccentric phase should take 2 seconds
4. Feel the bar touch your chest and begin to push against the bar with your hands
   - Feel the concentric contraction of your pectorals and triceps
   - See the bar moving away from you
   - Feel the air being forced out of your body as you extend your elbows and contract your diaphragm and abdominals exhaling the air in your lungs
   - Feel the tension building in your body
   - Feel your triceps contract as your arms become full extended
   - This should take 2 seconds to push the bar
5. Feel your arm fully straighten and the full contraction of your pectorals and triceps
6. Repeat steps 3 to 5 three more times
7. Once finished place the bar back on the rack
   - Hear the bar hit against the metal rack
   - Feel the relief of tension throughout your body
   - Feel the emotions after finishing a heavy set

Single Arm DB Row

1. See yourself putting your right knee on the bench
2. Now bend at your torso and put you right hand on the bench keeping your right arm staring

    - See your hand take the weight of your body
    - Feel your back stay straight
3. Bend over and grasp the dumbbell on the ground
    - Feel the weight in your hand as your holding the dumbbell
    - Feel your shoulder and back muscles holding your shoulder still
    - Feel the tension in your arm
4. Begin to row the dumbbell towards yourself
    - Feel the weight of the dumb
    - Your shoulder blade moving towards your spine
    - Feel your back muscles contract
5. Begin to lower the weight back down towards the ground
    - Feel your back muscles eccentrically resisting against the weight
    - Feel your forearms working as you hold the weight
6. Repeat steps 5 and 6 (4 more times)
7. Drop the weight
8. Rest

Romanian Deadlift

1. Picture yourself standing in front of the bar on the ground
    - See your hands grab the dumbbell
    - See the weight you use on the barbell (e.g., 25 lbs)
    - Feel the bumps on the bar and the hard metal
    - Feel the weight and hardness of the dumbbell as it rests in your hands as you grab it
    - Feel your adrenaline increase as you want to lift this heavy weight
2. Lift the barbell off the ground until you're standing straight
    - Feel the weight of the bar in your hands
3. Begin to lower your back while sticking your butt out keeping your arms straight, holding the dumbbell
    - Feel the pressure in your back, gluteus, quads and hamstrings as they resist the weight of the dumbbell
    - See yourself keeping your leg that is on the ground still
    - Feel your back staying straight and your gluteus and hamstrings eccentrically contracting
    - Feel your hips staying square
    - See yourself in the mirror moving downward until your back and legs are flat
    - Feel the air entering your lungs as you inhale
    - **** should take 2 seconds for eccentric phase
4. Once your back is parallel to the ground

    - Feel your gluteus and hamstring begin to concentrically contract overcoming the weight
    - Feel your foot start to lower and your back become more vertical
    - Feel your back tightening trying to stay straight and in a neutral spine
    - See yourself in the mirror to make sure your staying square and balance
    - Feel your gluteus contract as they stabilize the hips and bring your body back to straight
    - Feel you diaphragm in full contraction as you exhale with the contraction
    - *** should take 2 sec for concentric phase
5. Complete steps 3 and 4 ten times in total
6. After complete drop the weight
7. Feel the emotions, the fatigue in your muscle after completing a really hard set

Neutral Grip Shoulder Press

1. Picture yourself standing in front of the dumbbells
    - See them on the ground in front of you
    - See your hands grab the dumbbells
    - See the weight you use on the end of the dumbbell (e.g., 20 lbs)
    - Feel the bumps on the handle and the hard metal
    - Feel your adrenaline increase as you want to lift this heavy weight
2. Stand up straight holding the dumbbell
    - Feel the weight and hardness of the dumbbells in your hands
3. Raise the dumbbell in line with your shoulders
    - Feel your biceps and deltoids contract as you raise the dumbbells towards your shoulder
4. Turn your hands to a neutral grip (palms facing in)
5. Begin to press the dumbbell over your head
    - Feel your serratus anterior contract bring the scapula towards the spine and keeping your shoulders back
    - Feel the concentric contraction of your deltoids and trapezius
    - Listen for the dumbbells to lightly clang over your head
    - See yourself in the mirror raising the dumbbells
    - Feel your triceps contract as your arms become full extended
    - Feel you diaphragm in full contraction as you exhale with the contraction
    - This should take 2 seconds to raise the dumbbells

6. Once fully extended begin to lower the dumbbells towards your shoulder
    - Feel your elbows begin to bend as your deltoids, trapezius and triceps begin to eccentrically contract, resisting the weight being pushed against your muscles
    - See yourself in the mirror as the dumbbells lower
    - Feel the air entering your lungs as you inhale
7. Repeat steps 5 and 6 seven more times
8. Ones done lower the dumbbells to your waist and all the way to the ground
9. Feel the release in your muscles as you let go off the weights
10. Feel the emotions, the fatigue in your muscle after completing a really heavy set

Bicep Curl

1. Picture yourself standing in front of the dumbbells on the floor
    - See your hands grab the handle of the dumbbell on the ground
    - Feel the bumps and the metal handle
    - See what weight you will use (e.g., 200 lbs)
    - Feel your adrenaline increase as you want to lift this heavy weight
2. Stand up straight
    - Feel your quadriceps extend your knee
    - Feel the weight of the dumbbell in your hand
3. Position your elbows against your side
    - Feel your biceps begin to tighten as they prepare to contract
4. Begin to bend your elbows as you start the first rep
    - Feel the concentric contraction of your biceps and brachialis as your arm begins to bend at the elbow
    - Feel your deltoids and rotator cuff stabilize your shoulder and stop your humorous from moving
    - See your hand moving towards your shoulder
    - Feel the air being forced out of your body as you bend your elbows and contract your diaphragm and abdominals exhaling the air in your lungs
    - Feel the tension building in your body
    - Feel your biceps fully contract as your arms are in full flexion
    - Listen to the sound of the plate rattling on the end of the dumbbell
    - This should take 2 seconds to complete the concentric phase
5. Feel your arm in maximum flexion and the full contraction of your triceps
6. Feel your elbow begin to straighten as you begin the eccentric phase
    - Feel your biceps eccentrically contracting as the weight is moving towards your waist

    - Feel your elbows straightening
    - Feel your biceps resisting the weight
    - Feel your abdominals contract as you stabilize your body
    - See the dumbbell move past A 90 degree elbow flexion
    - Feel the air entering your lungs as you control your breathing, inhaling
    - The eccentric phase should take 2 seconds
7. Repeat steps 4 to 6 seven more times
8. Once finished put the dumbbells down on the ground
    - Hear them hit the ground
    - Feel the relief of tension throughout your body
    - Feel the emotions after finishing a heavy set
    - Feel the fatigue in your muscles

Overhead Tricep Extension

1. Picture yourself standing in front of the cable machine
    - See the pulley handle in front of you
    - See your hands grab the handle
    - See where the pin is on the rack and what weight you will use (e.g., 200 lbs)
    - See the pulley all the way to the top of the rack
    - Feel your adrenaline increase as you want to lift this heavy weight
2. Turn around so your back is against the cable machine
    - Feel the metal on your back and the cable handles in your hands
3. Push the cable out in front of you
    - Feel the tricep isometrically hold the weight as you move your leg in front and slightly bend your knee
    - Feel your quads and gluteus engage as they hold the lunge position
    - Feel the weight in your hands
    - Feel the air moving in and out of your lungs as you regulate your breathing
4. Move your hand to so they just above your head as you prepare for the first rep
    - Feel your abdominals contract as the stabilize your body
5. Feel your hand and the handle over your head and begin to push the cable away from your body
    - Feel the concentric contraction of your triceps as your arm begins to straighten
    - Feel your deltoids and rotator cuff stabilize your shoulder and stop your humorous from moving

  - See your hand moving away from your head
  - Feel the air being forced out of your body as you extend your elbows and contract your diaphragm and abdominals exhaling the air in your lungs
  - Feel the tension building in your body
  - Feel your triceps contract as your arms become fully extended
  - Listen to the sound of the cable moving up the rack
  - This should take 2 seconds to push the bar

6. Feel your arm fully straighten and the full contraction of your triceps
7. Feel your elbow begin to bend as you begin the eccentric phase
   - Feel your triceps eccentrically contracting as the weight is moving closer to your head
   - Feel your elbows bending
   - Feel your triceps resisting the weight
   - Feel your abdominals contract as you stabilize your body
   - See the cable coming closer to your head
   - Listen to the cable moving down the rack
   - Feel the air entering your lungs as you control your breathing, inhaling
   - The eccentric phase should take 2 seconds
8. Repeat steps 5 to 7 seven more times
9. Once finished let the cable fall in to place
   - Hear the handle hit the against the metal rack
   - Feel the relief of tension throughout your body
   - Feel the emotions after finishing a heavy set
   - Feel the fatigue in your muscles

STRENGTH 2:

Step into the Weight Room to Begin Strength 2

- See all the weights, benches and racks
- Feel the rubber floor under your feet
- Smell the weight room: the sweat, metal and rubber
- Listen to the sound of weights dropping, the music you listen to when you workout

Deadlift

1. Picture yourself standing in front of the bar on the ground
    - See your hands grab the bar
    - See the weight you use on the end of the bar (e.g., 200 lbs)
    - Feel the bumps on the bar and the hard metal
    - Feel your adrenaline increase as you want to lift this heavy weight
2. Step up to the bar
    - Feel the weight and hardness of the bar as it rests in your hands as you grab it
3. Lift the bar off the ground and begin to straighten your knees
    - Feel the weight of the bar in your hands
    - Feel the pressure in your back, gluteus, quads and hamstrings as they overcome the weight of the bar
    - See yourself straightening your knees in the mirror
    - Feel your back staying straight
    - Feel your quads and gluteus becoming fully contracted
    - Feel you diaphragm in full contraction as you exhale with the contraction
    - **** should take 2 seconds for concentric phase
4. Once straight begin to lower the bar back to the ground
    - Feel your gluteus and hamstring eccentrically contracting fighting against the weight
    - Feel your knees lowering, getting closer to 90
    - Feel your back tightening trying to stay straight and in a neutral spine
    - See yourself in the mirror to make sure you're getting all the way down
    - Feel and hear the bar hit the ground
    - Feel the air entering your lungs as you inhale
    - *** should take 3 sec for eccentric phase
5. Repeat steps 3 and 4 three more times

6. Once finished drop the bar and step back
    - Hear the bar hit the ground
    - Feel the bounce of the weights
7. Feel the emotions, the fatigue in your muscle after completing a really heavy set

Cable Chest Press

1. Picture yourself standing in front of the cable machine
    - See the pulley handle in front of you
    - See your right hand grab the handle
    - See where the pin is on the rack and what weight you will use (e.g., 200 lbs)
    - Feel your adrenaline increase as you want to lift this heavy weight
2. Push the cable out in front of you
    - Feel the pectorals and tricep isometrically hold the weight as you move one leg in front and lower into a lunge position
    - Feel your quads and gluteus engage as they hold the lunge position
    - Feel the weight in your hands
    - Feel the air moving in and out of your lungs as you regulate your breathing
3. Move your hands to your side as you prepare for the first rep
    - Feel your abdominals contract as the stabilize your body
4. Feel your hand and the handle by your side and begin to push the cable away from your body
    - Feel the concentric contraction of your pectorals and triceps
    - See your hand moving away in to the midline of your body
    - Feel the air being forced out of your body as you extend your elbows and contract your diaphragm and abdominals exhaling the air in your lungs
    - Feel the tension building in your body
    - Feel your triceps contract as your arms become full extended
    - Feel the full contraction of your pectorals
    - Listen to the sound of the cable moving up the rack
    - This should take 2 seconds to push the bar
5. Feel your arms fully straighten and the full contraction of your pectorals and triceps
6. Feel your elbows begin to bend as you begin the eccentric phase
    - Feel your pectorals and triceps eccentrically contracting as the weight is moving closer to your body

    - Feel your elbows bending
    - Feel your pectorals and triceps resisting the weight
    - Feel your abdominals contract as you stabilize your body
    - See the cable coming closer to your side
    - Listen to the cable moving down the rack
    - Feel the air entering your lungs as you control your breathing, inhaling
    - The eccentric phase should take 2 seconds
7. Repeat steps 4 to 6 seven more times
8. Once finished let the cable fall in to place
    - Hear the handle hit the against the metal rack
    - Feel the relief of tension throughout your body
    - Feel the emotions after finishing a heavy set
    - Feel the fatigue in your muscles

Double Arm Cable Row

1. Picture yourself standing in front of the cable machine
    - See the pulley handles in front of you
    - See your hands grab the handles
    - See where the pin is on the rack and what weight you will use (e.g., 200 lbs)
    - Feel your adrenaline increase as you want to lift this heavy weight
2. Pull the cable out towards you
    - Feel the Trapezius and latisimus dorsi isometrically hold the weight as you move your legs shoulder width apart and lower into a squat position
    - Feel your hamstrings and gluteus engage as they hold the squat position
    - Feel your erector spinae group and abdominals stabilize your body as they kept you back up straight
    - Feel the weight in your hands
    - Feel the air moving in and out of your lungs as you regulate your breathing
3. Extend your arms out in front of you as you prepare for the first rep
    - Feel your abdominals contract as the stabilize your body
    - Feel the trapezius isometrically contract holding the weight
4. Feel yourself begin to pull the hand towards your body squeezing your shoulder blades together
    - Feel the concentric contraction of your trapezius, biceps, rotator cuff and rear deltoids

- See your hands moving towards the midline of your body
    - Feel the air being forced out of your body as you bend your elbows and contract your diaphragm and abdominals exhaling the air in your lungs
    - Feel the tension building in your body
    - Listen to the sound of the cable moving up the rack
    - Feel your trapezius contract as your arms become full flexion and your shoulder blades close to your spine
    - Feel the full contraction of your trapezius
    - This should take 2 seconds to push the bar

5. Feel your arm fully bent and the full contraction of your trapezius, biceps, rotator cuff and rear deltoids
6. Feel your elbow begin to straighten and the shoulder blades move slightly away from your spine as you begin the eccentric phase
    - Feel your trapezius and biceps eccentrically contracting as the weight is moving away from your body
    - Feel your elbows bending
    - Feel your trapezius and biceps resisting the weight
    - Feel your abdominals contract as you stabilize your body
    - See the cable moving further away
    - Listen to the cable moving down the rack
    - Feel the air entering your lungs as you control your breathing, inhaling
    - The eccentric phase should take 2 seconds
7. Repeat steps 4 to 6 three more times
8. Once finished let the cable fall in to place
    - Hear the handle hit the against the metal rack
    - Feel the relief of tension throughout your body
    - Feel the emotions after finishing a heavy set
    - Feel the fatigue in your muscles

Incline DB Press

1. Picture yourself lying on the incline bend
    - Feel the pad on the bench you are lying on and the ground under your feet
    - See the bar in above you
    - See your hands grab the dumbbells
    - See the weight you use on the end of the dumbbell (e.g., 20 lbs)
    - Feel the bumps on the bar and the hard metal
    - Feel your adrenaline increase as you want to lift this heavy weight

2. Lift the dumbbell to the air
    - Feel the weight in your hands
    - Feel the air moving in and out of your lungs as you regulate your breathing
3. Begin to lower the dumbbells towards your chest
    - over your head
    - Feel your pectorals and triceps eccentrically contracting as the weight is being lowered
    - Feel your elbows begin to bend
    - Feel your abdominals contract as you stabilize your body
    - See the bar coming towards you
    - Feel the air entering your lungs as you control your breathing, inhaling
    - The eccentric phase should take 2 seconds
4. Feel the dumbbells touch your chest and begin to push against the bar with your hands
    - Feel the concentric contraction of your pectorals and triceps
    - See the bar moving away from you
    - Feel the air being forced out of your body as you extend your elbows and contract your diaphragm and abdominals exhaling the air in your lungs
    - Feel the tension building in your body
    - Feel your triceps contract as your arms become full extended
    - This should take 2 seconds to push the bar
5. Feel your arm fully straighten and the full contraction of your pectorals and triceps
6. Repeat steps 3 to 5 three more times
7. Once finished place the dumbbells on the ground
    - Hear the dumbbells hit the ground
    - Feel the relief of tension throughout your body
    - Feel the emotions after finishing a heavy set
    - Feel the fatigue in your muscles

Double Arm Cable Lat Pulldown

1. Picture yourself standing in front of the cable machine
    - See the pulley handles in front and slightly above yourself
    - See your hands grab the handles
    - See where the pin is on the rack and what weight you will use (e.g., 200 lbs)
    - Feel your adrenaline increase as you want to lift this heavy weight

2. Pull the cable out towards you
    - Feel the Trapezius and latisimus dorsi isometrically hold the weight as you move your legs shoulder width apart and lower into a squat position
    - Feel your hamstrings and gluteus engage as they hold the squat position
    - Feel your erector spinae group and abdominals stabilize your body as they kept you back up straight
    - Feel the weight in your hands
    - Feel the air moving in and out of your lungs as you regulate your breathing
3. Extend your arms out in front of you as you prepare for the first rep
    - Feel your abdominals contract as the stabilize your body
    - Feel the trapezius isometrically contract holding the weight
4. Feel yourself begin to pull the hand towards your body on a 45 degree angle squeezing your shoulder blades together
    - Feel the concentric contraction of your latisimus dorsi, biceps, rotator cuff and rear deltoids
    - See your hands moving towards the midline of your body
    - Feel the air being forced out of your body as you bend your elbows and contract your diaphragm and abdominals exhaling the air in your lungs
    - Feel the tension building in your body
    - Listen to the sound of the cable moving up the rack
    - Feel your trapezius contract as your arms become full flexion and your shoulder blades close to your spine
    - Feel the full contraction of your trapezius
    - This should take 2 seconds to push the bar
5. Feel your arm fully bent and the full contraction of your latisimus dorsi, biceps, rotator cuff and rear deltoids
6. Feel your elbow begin to straighten and the shoulder blades move slightly away on a 45 degree angle from your spine as you begin the eccentric phase
    - Feel your latisimus dorsi and biceps eccentrically contracting as the weight is moving away from your body
    - Feel your elbows bending
    - Feel your trapezius and biceps resisting the weight
    - Feel your abdominals contract as you stabilize your body
    - See the cable moving further away

    - Listen to the cable moving down the rack
    - Feel the air entering your lungs as you control your breathing, inhaling
    - The eccentric phase should take 2 seconds
7. Repeat steps 4 to 6 three more times
8. Once finished let the cable fall in to place
    - Hear the handle hit the against the metal rack
    - Feel the relief of tension throughout your body
    - Feel the emotions after finishing a heavy set
    - Feel the fatigue in your muscles

MOTOR IMAGERY IMPLEMENTATION TEMPLATE

Keywords

- Maximal muscular contraction
- Feel the movement
    - Tension of weight
    - Muscles moving
    - Joints bend and straighten
- Feel the bar
    - In your hands
    - On your shoulders
- See yourself in the mirror
- Hear the sound of the weights hitting together

Strength 1 Motor Imagery

- Back Squat
    - Feel the hamstrings contract
    - Feel your knees bend
    - Feel your knees straighten and gluteus maximus contract
    - Feel the weight on your shoulders
- Split Squat
    - Feel the hamstrings contract
    - Feel your knee bend
    - Feel the straight in trailing quad
    - Feel your knees straighten and gluten contract
    - Feel the weight in your hands
- Bench Press
    - Feel the tension in your pectorals as they contract
    - Feel your arms straighten
    - See the bar come above your head
    - Feel your elbows bend
- Single Arm Bent Over DB Row
    - Feel your elbows bend
    - Feel the tension in your trapezius and biceps as they contract
    - Feel your elbows straighten
    - See your arms move away from your body
- Romanian Deadlift
    - Feel the tension in your gluteus maximus as your body comes to parallel

    - Fell you back and abdominal muscles stiffen
    - Feel your hamstring an gluteus maximus bring your body back to straight
- Neutral Grip Shoulder Press
    - Feel your hands pressing above your heads
    - Feel the tension in your deltoids an scapular stabilizers
    - Feel your elbows bend
- Bicep Curl
    - Feel your elbow bend as your hand comes towards your shoulder
    - Feel the tension in your bicep
    - Feel your elbow straighten
- Overhead Tricep Extension
    - Feel your elbow straighten as your hands move away from your shoulder
    - Feel the tension in your tricep
    - Feel your elbow bend

Strength 2 Motor Imagery

- Deadlift
    - Feel the gluteus maximus contract
    - Feel your knees straighten
    - Feel your knees bend and hamstrings contract
    - Feel the weight in your hands
- Double Arm Cable Press
    - Feel your legs, abdominals and back stiffen to hold your position
    - Feel you pectorals contract
    - Feel your arms straighten
    - See cable move away from your body
    - Feel your elbows bend
- Double Arm Cable Row
    - Feel your elbows bend
    - Feel the tension in your trapezius and biceps as they contract
    - Feel your elbows straighten
    - See your arms move away from your body
- Incline DB Press
    - Feel the tension in your pectorals as they contract
    - Feel your arms straighten
    - See the bar come above your head
    - Feel your elbows bend

- Double Arm Cable Lat Pulldown
  - Feel your elbows bend moving on a 45 degree angle
  - Feel the tension in your latismus and biceps as they contract
  - Feel your elbows straighten
  - See your arms move away from your body

APPENDIX I

STUDY DEBRIEF LETTER

We greatly appreciated your participation in our study, and thank you for spending the time helping us with our research. When you began the study, you were told that the purpose of this study was to examine the effects of mental focusing and motivational techniques on strength performance. However, the study was more complicated than we explained at the beginning. Motor imagery has been found to increase strength performance in a ‘isometric” or still contraction. We are interested in whether motor imagery could increase the strength performance of a “dynamic” or moving muscle contraction. To examine this was one group received only the strength training program and one group received a motor imagery and strength training program. Your “dynamic” or moving strength was assessed using the one repetition bench press and three repetition back squat test.

In this study, each participant received a 13 week strength training program starting in September 2012 and ending in December 2012. Each participant was randomly placed in either the motor imagery intervention or the control group. Both groups received the exact same strength training program, and participated in the same testing sessions. If you were in the motor imagery intervention you completed motor imagery training throughout the study in combination with the strength training. If you were in the control group you were asked to listen to your favorite motivational music throughout the workout. At the end of each workout both groups were then asked how effective they perceived the music or motor imagery to be. This allowed us not only to compare the difference in strength between the two groups but also how effective you found each intervention to be.

We could not give participants complete information about the study before their involvement because it may have influenced participants’ behaviour during the study in a way that would make investigations of the research question invalid. The reason that we used deception in this study was because we needed participants' behaviour and attitudes to be unaffected by the study objectives. We apologize for omitting details and for providing you with fictional information about the purpose of and tasks in our study. We hope that you understand the need for deception now that the purpose of the study has been fully explained to you.

We would just like to re-iterate a few things:

- The purpose of this study was to test whether motor imagery in combination with strength training would have a greater effect on strength performance than strength training alone
- Both participant groups received the same strength training

If any concerns or comments about your participation in this please feel free to contact the Principal Investigator Jesse Adams, at (902)-452-7683 or email at jesse.adams@dal.ca. You can also contact my faculty supervisors, Dr. Melanie Keats at (902) 494-7173 melanie.keats@dal.ca or Dr. Carolyn Savoy at (902) 494-2152, carolyn.savoy@dal.ca. Also, please feel free to contact Catherine Connors at the Dalhousie Research Services Office at (902) 494-3423, ethics@dal.ca.

The information you provided will be kept confidential by not associating your name with the responses. The data will be stored with all identifying or potentially identifying information removed. Electronic data will be stored 7 years on a password protected computer then destroyed. Printed data will be kept in a locked filing cabinet in a locked room within the Dalplex for 7 years then destroyed by confidential shredding. No one other than the researchers will have access to the data.

We really appreciate your participation, and hope that this has been an interesting experience for you.

POST-DEBRIEFING CONSENT FORM FOR STUDIES INVOLVING DECEPTION

Study Title: The Effects of Motor Imagery on Strength Performance

Faculty Supervisor:	Dr. Carolyn Savoy	Dr. Melanie Keats
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During the debriefing session, I learned that it was necessary for the researchers to disguise the real purpose of this study. I realize that this was necessary since having full information about the actual purpose of the study might have influenced the way in which I responded to the tasks and this would have invalidated the results. Thus, to ensure that this did not happen, some of the details about the purpose of the study initially were not provided (or were provided in a manner that slightly misrepresented the real purpose of the study). However, I have now received a complete verbal and written explanation as to the actual purpose of the study and have had an opportunity to ask any questions about this and to receive acceptable answers to my questions.

I have been asked to give permission for the researchers to use my data (or information I provided) in their study, and agree to this request. I am aware that I may withdraw this consent by notifying the Faculty Supervisor of this decision.

I am aware this study has been reviewed and received ethics clearance through the Office of Research Ethics and I may contact Catherine Connors at the Dalhousie Research Services Office at (902) 494-3423, ethics@dal.ca if I have any concerns or comments resulting from my involvement in this study.

Participant's Name: ____

Participant's Signature: ____

Date: ____________________________

Witness' Name: ____

Witness' Signature: ____

APPENDIX J

PERCEIVED EFFECTIVENESS (MOTOR IMAGERY) TEMPLATE

ID#	

How vivid were your image of the upper body

1	2	3	4	5
No image performed at all	Partially performed	Neutral	well performed	Vivid image could be performed

1	2	3	4	5
No image performed at all	Partially performed	Neutral	well performed	Vivid image could be performed

1	2	3	4	5
Not at all	Part of the time	Neutral	Most of the time	Everytime

PERCEIVED EFFECTIVENESS (MOTIVATIONAL MUSIC) TEMPLATE

ID#				
How effective was listening to Motivational Music in aiding your training				
1	2	3	4	5
Music was not effective	Partially effective	Neutral	Quite effective	Music was extremely effective

APPENDIX K

MOTOR IMAGERY EXIT INTERVIEW GENERAL COMMENTS

Aiding in learning exercise technique

- 12- I feel the motor imagery helped because I was able to practice the movement more w/o actually doing it …and becoming physically tired
- 13-I found it improved, because after doing exercise and trying to visualize it helped my nervous system remember / know how to feel what it should be experiencing
- 13-I found that the back squats that once I learnt how to correctly image the exercise it helped performance in skill
- 14- I think it improved, because you could focus on which muscles were supposed to be working during the exercise
- 14- I think that feeling the muscles do the exercise while doing the imagery, I found it easier to focus on my lower body muscles, (i.e. back squat)
- 20- Improved technique, it would allow for more reflection on the exercises I was doing
- 20- Imaging correctly helped improve technique continuous constant reminder of proper technique
- 20- For example single arm DB row found physically head down w/ shoulder sag
- 20- When imaged made sure head up w/ set shoulder
- 20- Felt that second lift was often better than first… for most part found it was technique being reaffirmed through imagery
- 24-I found the motor imagery helped because you could focus a lot more on the specific aspects of it, if you just do it physically you could be just focused on getting through the pain or physical exertion, where if you do motor imagery you can focus on just squatting
- 24- Obviously my technique will have improved but doing the imagery helped me be more conscious of the technique and how to improve it
- 24- I feel it had an impact on both, but a stronger impact on lower
- 24- It helped with upper body because I focused on the technique and feeling of doing the movement
- 24- When it is an exercise you are not familiar with you not sure if doing right
- 24- I was able to reinforce this with bench press for examples i.e. where to bring body down

Timing of Motor Imagery

- 8- I think because doing visualization I could feel upper body (both picture and feel) so when doing movement felt could do more because I was visualizing while doing it
- 12- I feel it did because I was able to feel movement more when doing it…helped me identify when doing it physically if I was doing it wrong or right….
- 12- I found when imaging after doing an exercise if I feel the exercise a lot (exertion) I would feel it more when imaging
- 13- I found trying to feel motion when imaging after doing it helped gain more focus points while doing imagery
- 13- found when started with motor imagery in room was harder to grasp but when started w/ exercises I found exercises increased my ability
- 13- For example if we did two motor imagery sets after doing two physical sets
- 14-I felt it was more vivid right after an exercise, mainly with bench press and back squat and split squat
- 14- I remember feeling more stress put on the muscle… kind of like you were doing the real exercise
- 20-By doing in b/w exercises was doing mentally while doing physical movement

Impact on strength

- Quality
  - 8-I think doing visualization of upper body I could feel the upper body (visual and kinesthetic)… this allowed me to feel I could do more physically
  - 12- "It was a cyclical relationship, better I lifted, lead to higher quality imagery, which lead to more quality lifting. It kept on going".
  - 24- I would say I feel my experience with the exercise effected my ability to image
  - 24- More experience with exercise=strong= more positive emotions (CONFIDENCE and positive emotions)
    - i.e. bench press I hated at the start
  - 24- once I got better I hated less and motor imagery improved
  - 24- I think it (*strength gains*) for me came down to being able to image it (exercises) more vividly. But as I felt that there was more confidence in physical exercise there was more in motor imagery it was cyclical relationship
  - 24- I feel when I imaging I am really specific and do the emotions really slowly, this would result in better imagery

- Stressing muscles
    - 13- I found that I even felt tired even when I didn't do as much (*physical* exercise) I felt tired and I was still stressing the muscles using motor imagery even though physical was down
    - 13- for example in the taper I felt similar fatigue when I did more motor imagery and not as much exercise
    - 14- I feel that I could feel it (motor imagery) in my muscles,
    - 20- I Found like it is was still useful during taper I felt it was still working muscles, especially more benefit in doing motor imagery then sitting at home doing nothing
    - 20- I felt it reinforce what muscles have learnt
    - 20- I was unsure at first, when started lifting in first couple weeks and saw bigger gains from this strength when compared to gains in previous workouts outside of study
    - 24- As I continued I found the imagery more difficult (exertion wise) because I would see the weight being heavier, because I was doing heavier physically
    - 24- I think the main reason was because I became more familiar with the exercise
    - 24- At the start it was more difficult but later on the imagery became more vivid and real and I could trick myself into my muscles almost shaking

Ease of incorporating motor imagery practically

- 12- I wasn't very strong in my upper body, but was I was lifting at end I don't think I could of lifted that much at the end …as said before I could feel it more and it made me want to push myself more
- 12- I found it fairly easy to maintain, sometimes I had to remind myself to make sure I was doing all the imaging not just partial reps
- 20 I found it easy, both for technique and once I got into the routine especially for big exercise and once I started feeling there were gains felt I didn't want to miss any motor imagery
- 20- I feel it Helped focus on lifting not outside distractions
- 20- As well as motivation
- 20- The more I did the more I wanted to push and succeed at it
- 20- I would do it right before lift to bring in focus and motivation on what I was about to do
- 20- Once started feeling there were gains felt didn't want to miss any motor imagery

- 24- As the study progressed you could see results... I am sure there would be results without imaging but I felt like it was more so

Impact of Previous Exercise Experience on Imagery Perceived Effectiveness

- 8- Did not find using imagery help with physical technique with lower body
    - Found useful with upper body
    - Found with external visualization really useful
    - Found the kinesthetic aspect of movement difficult
        - Especially squats and deadlifts never had done physical movement to that degree of intensity
        - Feels training experience impacts ability to feel movement
    - Wasn't negative just not as positive as I thought it would be
- 24- I would say, I feel my experience with the exercise effected my ability to image
    - More experience with exercise=stronger imagery= more positive emotions (CONFIDENCE and positive emotions)
    - i.e. bench press I hated at the start once I got better I hated less and motor imager improved
- At the start I wasn't good at imaging…I was better at lower body then upper body
    - I thought it was because I was used to training lower body more
    - I found a hard time with upper

Motivational Music Exit Interview General Comments

Listening to music was motivating

- 1- I feel that the music would help get another rep… especially if I was in the mood for it
- 3- I feel listening to music was a positive impact if there was no music it would be kind of boring listening to the music made it more enjoyable…so I guess it was motivational
- 5- Yes sometimes I found it motivating, but not focusing on the technique, only sometimes if it was the proper music and if it was loud enough. It had to be the right pump up music
- 5- It pushed me to go to the next weight
- 15- Found it improved ability to exercise
- 15- Motivation and mood
- 15- Focused on what should be doing
- 15- When louder motivated more to do a better job (to an extent)!!! Made more motivated to do it
- 15- Especially when knew songs and was the genre of music I identified with
- 15- Wanted to do the exercise with more weight
- 15- I felt pumped to do exercise
- 18- Sometimes I found that listening to music focus
- 18- Sometimes felt if really tired the music would focus/motivate you to do one more exercise rep

Listening to music had no impact on strength

- 1- feel if I was listening to music or not I would have had the same gains in strength
- 3-I feel the music didn't really matter, If I was improving I would have improved either way with or without the music, I feel the music didn't impact me one way or the other
- 5- No I wouldn't have same effects if I was listening to music
- 15- I felt the routine (working out 3 times a week) and repetition of doing exercise consistently, working different muscles impacted my change in strength
- 18- feel the music was there did not impact directly on strength